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. August 2015.

Welcome

It's hard to believe that we're covering a species in this issue that is on the cusp of going extinct, yet a single breeding female lays 400-500 eggs at a time. How can this situation have arisen? Well, you don't need to be a clairvoyant to work it out – it's basically down to us. Human interference in the environment and greed are the causes.

What makes the case of the Chinese giant salamander particularly tragic is the fact that it is the largest of all the world's 7,500 amphibian species currently alive. It represents the only direct link that we have back to the age of giant amphibians, around 230-290 million years ago, long before the rise of the dinosaurs, when this group of creatures was the dominant life form on planet Earth.

A typical example from that era was a creature called *Prionosuchus*, whose remains have been unearthed in present-day Brazil. It was remarkably similar in appearance to a modern-day crocodilian, and appears to have fulfilled a similar evolutionary niche as a predator, hunting fish. Its narrow snout is strongly reminiscent of that of the gharial, and it grew to around 4.5m (14.75ft).

The Chinese giant salamander is rather similar in basic form to many of the rather plain and much, much smaller salamanders that can be encountered in North America and elsewhere today. It's not a glamorous animal, unlike the giant panda or African elephant, and yet, encouragingly, people who have seen the only individual of its kind on display here in the UK are apparently very intrigued by it, according to those looking after it.. This is good news, but surely, more should be done?

Why is not every zoological collection in the country being encouraged to display this species? Its reproductive potential is massive. A single spawning would provide almost enough offspring to allow this aim to be achieved.

But zoos simply do not have the resources, in terms of time, money and space to act as a Noah's ark for every species or distinctive populations at risk. Is it not time, therefore, for the establishment of an organisation that links zoos and private breeders, who exist in much larger numbers, to come up with a list of species that can be the subject of collaborative breeding programmes, based on set protocols?

We are living in an ever-more uncertain world for the survival of amphibians, which are now confronted by additional threats such as climate change and the ravages of deadly chytrid fungus. Surely everyone concerned by their plight and willing to make a positive commitment to their future should come together to provide a refuge for a far greater number of species than can be assisted by zoos alone?

David Alderton

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✣ David has extensive practical experience with this group of creatures, extending back over 40 years. He has written and broadcast widely about their care and biology, and his website can be found at www.petinfoclub.com

Main cover image: A pair of the red form of the arboreal alligator lizards called *Abronia lythrochila* (photo courtesy Eco Exotics.

Contents

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News & Views

Featuring news this month about a remarkable group of miniature frogs found in Brazil, how zoos are attempting to save one of Australia's rarest frogs and starting with some remarkable news about panther chameleons that will impact on breeding programmes.

More panthers on the prowl

A panther chameleon from the area of Marozevo, Madagascar.

Madagascar is home to extraordinary biodiversity, but in the past few decades, the island's forests and wildlife have been under greater attack than ever. Rapid deforestation is affecting the habitat of hundreds of species, including the panther chameleon, a lizard that occurs in a spectacular range of colour forms.

A new study by a team led by Michel Milinkovitch, professor of genetics, evolution, and biophysics at the University of Geneva (UNIGE), carried out in close collaboration with Professor Achille Raselimanana of the University of Antananarivo and colleagues in Madagascar, has now revealed that this charismatic reptilian species, which is endemic there, is actually not a single species, but 11!

Informative drops of blood

It took two expeditions for the scientists to collect a drop of blood from each of 324 individual panther chameleons that were recorded by means of colour photographs.

➤ The established range of panther chameleons on Madagascar.
Map courtesy rbrausse.

The DNA of all of the specimens were sequenced and analysed in the laboratory, according to the hypothesis that a chameleon's dominant colour might be related to the geographic zone where it is found.

Most importantly, the study indicated that there was strong genetic structure among geographically restricted lineages, meaning that there was very low interbreeding among the different populations. Rather than locales, these chameleons have diverged into different species, based on the results of this study.

A key for turning genetics into colours

The mathematical analyses of the 324 colour photographs demonstrated that subtle colour patterns could efficiently predict assignment of chameleon individuals to their corresponding genetic lineage. This confirmed that many of the geographical populations might need to be considered separated species.

The scientists then simplified their analyses of the colour diversity into a classification key, which means that it is possible to link most chameleons to their corresponding species using only the naked eye. This case of hidden speciation confirms a major characteristic of Madagascar: it is amongst the most diverse places for life on Earth, serving as a biodiversity hotspot.

Each of the new chameleon species requires individual management, given that they constitute a different part of the biodiversity of the island. The visual classification key devised by the researchers could assist local biologists and trade managers to avoid local population over-harvesting.

The task of biodiversity management is daunting because of the widespread destruction of the forest habitat for agriculture, as well as for firewood and charcoal production. These human activities threaten the survival of 400 species of reptile, 300 species of amphibian, 300 species of bird, 15,000 species of plants and countless species of invertebrates. In addition, approximately 80 to 90% of all living species found in Madagascar are endemic, meaning they exist nowhere else on earth, making this a truly unique environment.

** You can read more about the unique fauna of Madagascar, accompanying Joshua Ralph as he heads out into the island's forests.* *See page 38 in this issue.*

➤ The Nosy Be form of the panther chameleon – isolated on an island off Madagascar's north-western coast, and meriting recognition as a separate species?

Further information

Djordje Grbic, Suzanne V. Saenko, Toky M. Randriamoria, *et al.* **Phylogeography and Support Vector Machine Classification of Colour Variation in Panther Chameleons.** *Molecular Ecology*, May 2015 DOI: 10.1111/mec.13241

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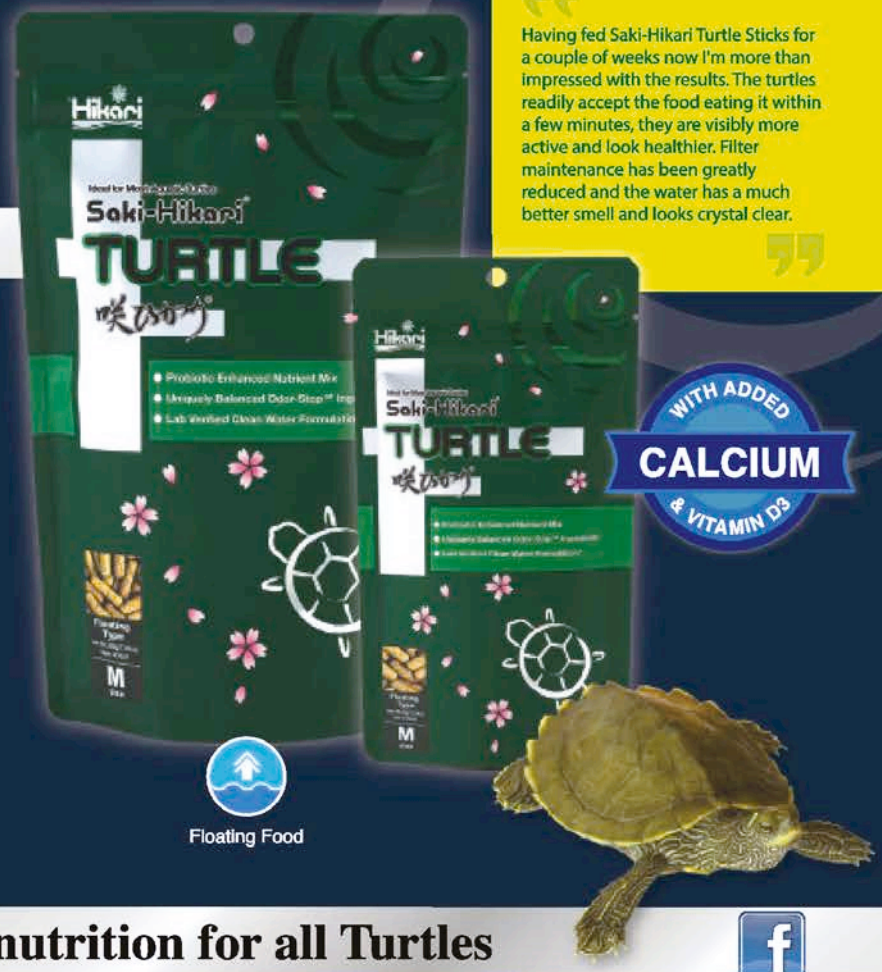

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> Having fed Saki-Hikari Turtle Sticks for a couple of weeks now I'm more than impressed with the results. The turtles readily accept the food eating it within a few minutes, they are visibly more active and look healthier. Filter maintenance has been greatly reduced and the water has a much better smell and looks crystal clear.

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Help for the critically endangered corroboree frog

Staff from Taronga Zoo in Sydney, Australia have recently released over 1,100 critically endangered southern Corroboree frog eggs in Kosciuszko National Park as the snow fell over their natural subalpine habitat. The eggs, produced at Taronga Zoo and Zoos Victoria, were released into a variety of natural and artificial pools as well as disease-free enclosures, as part of an ongoing recovery effort to bolster population numbers of this rare frog.

The southern corroboree frog (*Pseudophryne corroboree*) is one of Australia's most threatened animals, with less than 50 mature frogs in the wild. They have been in a state of decline for over three decades due to the devastating disease caused by the amphibian chytrid fungus. The fungus was introduced to Australia in the 1970s and has been responsible for the extinction of six frog species in Australia and up to 200 species around the world.

Corroboree frog with eggs. Photograph Michael McFaddon.

Captive-breeding provides the key

To prevent the extinction of this iconic species, an insurance population with over one thousand frogs has been established at four zoos and a university under the guidance of NSW Office of Environment and Heritage. The conservation programme has been very successful in recent years, with eggs put back to bolster the wild population each year since 2010.

The latest batch of eggs just released will slowly develop into tadpoles as their pools drop to almost freezing temperatures during winter. Once spring arrives, tiny black and yellow frogs will emerge to then enter the surrounding bogs and forests where they will grow for a further four to five years, before coming back to these pools to breed.

Herpetofauna Supervisor, Michael McFadden, explains: "We're releasing the eggs using a number of reintroduction techniques in order to maximise our chances of establishing populations of corroboree frogs within the park.

"By undertaking the releases in an experimental manner, it will allow us to continually learn and improve the techniques required to rebuild populations of this species."

Tiny frogs found

Following nearly five years of exploration in mountainous areas of the southern Brazilian Atlantic rainforest, a team of researchers has uncovered seven new members of the genus *Brachycephalus*. a group of miniature, brightly coloured frogs. Each species is very localised, being restricted to cloud forests. This makes them highly vulnerable to extinction, particularly due to shifts in the distribution of cloud forest as the result of possible climate change.

What is known about them

This group of frogs has intrigued naturalists for over a century, ranking amongst the smallest terrestrial vertebrates, with adult sizes often not exceeding 1cm (0.4in) in length. This scaling down in size has led to a variety of changes in their body structure, such as reduction in the number of toes and fingers. In addition, many species of *Brachycephalus* are brightly coloured, possibly as a warning to the presence of a highly potent neurotoxin in their skin, known as tetrodotoxin. Most species of *Brachycephalus* are highly endemic, being found exclusively on one, or a few, adjacent mountaintops. Such high levels of endemism are the result of the way they have adapted to a specific kind of habitat - the cloud forests - that simultaneously prevents them from migrating across valleys. This isolation also promotes the formation of new species.

➤ One of these tiny new species of frog. It is easy to see how they could be overlooked in an area. Photo courtesy Luiz Fernando Ribeiro, CC BY SA.

The first species of *Brachycephalus* was described in 1842 by the famous German naturalist Johann Baptist von Spix, yet most species in the genus have been discovered only in the past decade, particularly because they are so localised, and also because of the difficulty in reaching remote mountainous sites where they are to be found.

"Although getting to many of the field sites is exhausting, there is always the feeling of anticipation and curiosity about what new species could look like," explains Marcio Pie, a professor at the Universidade Federal do Paraná, who led the project.

Looking to the future

Luiz Ribeiro, a research associate based at the Mater Natura Institute for Environmental Studies, is optimistic about the prospects for future studies. "This is only the beginning, especially given the fact that we have already found additional species that we are in the process of formally describing."

A major concern regarding the new species is that the same factors that led to them becoming localised and forming new species could also turn out to be their ticket to their extinction. Cloud forests are highly sensitive to climatic changes, and the long-term preservation of these amphibians might involve not only the protection of their habitats but also more direct management efforts, such as rearing these frogs in collections.

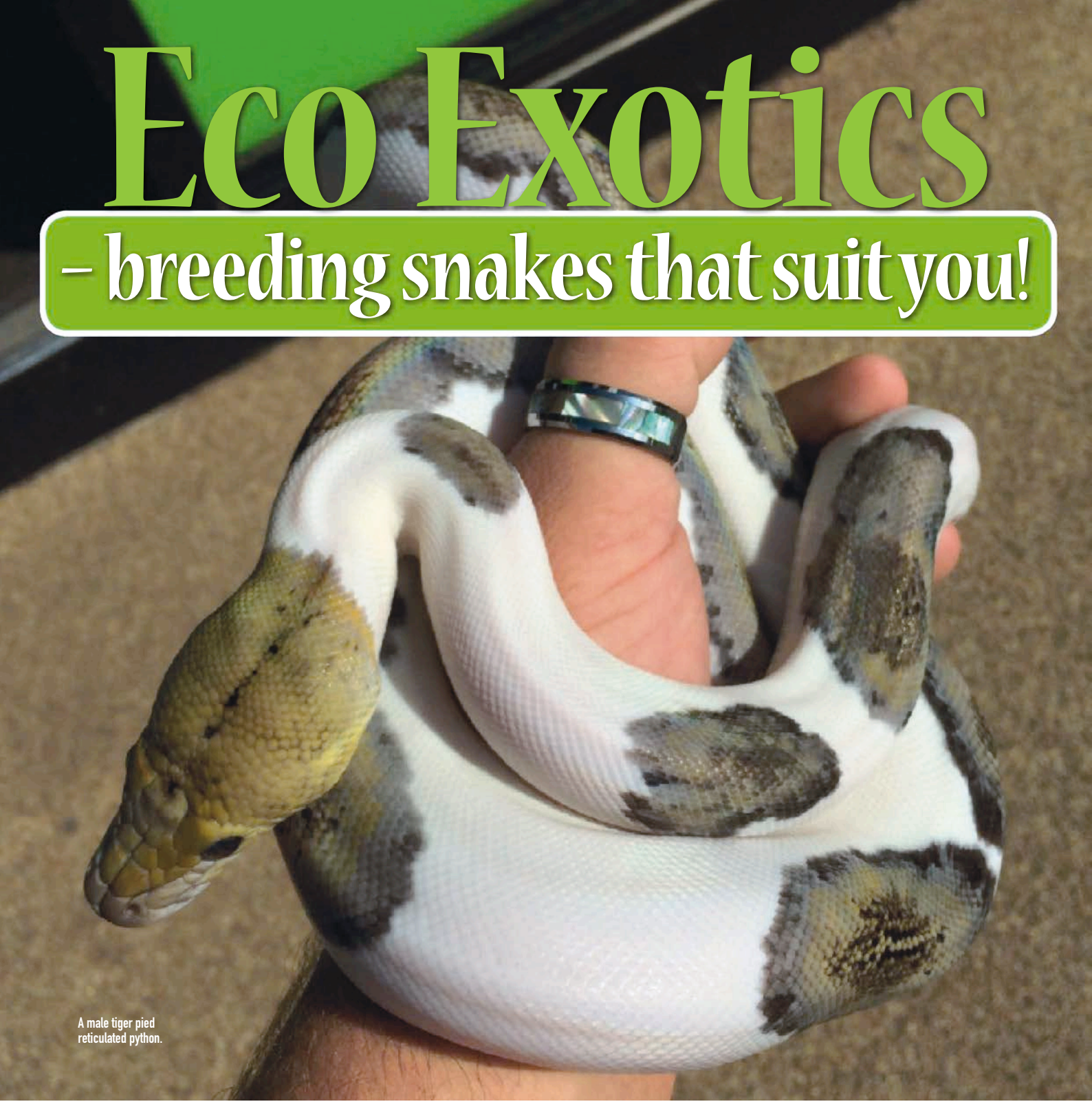
➤ Two of the new species of miniaturised frog found in the Brazilian Atlantic Forest are pictured. Left image is of *Brachycephalus auroguttatus* and below image is of *Brachycephalus verrucosus*. Photo courtesy Luiz Fernando Ribeiro, CC BY SA.

Further information

Robeiro, L F *et. al.* **Seven new microendemic species of *Brachycephalus* (Anura: Brachycephalidae) from southern Brazil.** *PeerJ,* June 2015 DOI: 10.7717/peerj.1011

Eco Exotics

– breeding snakes that suit you!



A male tiger pied reticulated python.

Discover the truth about small reticulated pythons, that are much easier for most people to accommodate and look after than their mainland cousins. John Courteney-Smith also finds out about a group of little-known yet stunning tree lizards on his visit to Eco Exotics.

I admit that it is not uncommon for me to become fixated upon a single species or even group of species. I like to find out all that I possibly can about the animals in question, and then move on to the next, amassing knowledge. Some people quite rightly describe this an obsession; personally, I call it 'being me'!

Breeding basics

There are, however, a few keepers out there who take their obsession to the next level. They become both dedicated to and consumed by their choice, discovering all that they possibly can about it and replicating its natural habitat as closely as possible, with the aim of being able to breed more individuals, and increase interest in the species. For me, breeding is the number one goal that we should all have in the case of more unusual species that are not well-represented in collections as yet.

Then of course, there are the species such as leopard geckos that are already commonly bred but where keepers are keen to develop particular strains, notably in terms of creating colour morphs, and accumulating genetic knowledge about the primary mutations with this in mind. Breeding challenges of this type are not new, with the ability to influence the appearance of livestock for a variety of reasons having been a common purpose for people around the world since before the dawn of history; we only have to look at the dog as an example.

How problems arise

I myself have had serious concerns about the possible long-term outcomes of the sheer numbers of potentially giant reticulated pythons that have been bred over the last few years. Now please don't get me wrong; I am not 'anti-big snake' – not at all. No, I believe that if you have the knowledge, the space and budget to care

➤ A female Madu super dwarf reticulated python.

➤ A black-eyed leucistic reticulated python.

for one or more of these snakes, then you have a right to do so. Sadly though, many people do not, and this can lead to various problems as the snakes get larger.

The focus at Eco Exotics

I was therefore greatly interested in a brand new captive-breeding project that is being started at Eco Exotics, based at Southampton in the south of England. Dave and his team there are now working with the super dwarf reticulated pythons. They aim to use a rare locality variant of this snake to breed retics that will grow to less than 2.4m (8ft). This represents a much more easily managed size of snake that will appeal to a larger group of snake keepers.

I met up with Dave recently and talked with him about this project. We had also been working together with a breeding group of arboreal alligator lizards (*Abronia* species) that have really grabbed my attention. Their distribution ranges from Mexico down to northern parts of South America, and they have been known to climb up to heights of 40m (130ft) in trees. There are currently 28 species recognised, but none is commonly seen in collections at present, so we ended up discussing his studies with these lizards as well.

Origins of the dwarf reticulated pythons

Q I am delighted to see these first few eggs of the dwarf reticulated pythons starting to hatch. Please can you explain the process of how you tracked down your breeding stock of these pythons and the locality in which they are found in the wild?

A Thanks, John. Yes, we are over the moon with the first couple of clutches of these pythons that we have had hatch this season. Sourcing the adults has been no easy task, partly because we have been very particular about the localities represented in our collection.

We work with Korompa Islands form, which is the smallest of all the super dwarf (often abbreviated to SD) varieties. These snakes rarely exceed 1.8m (6ft) long and have a similar build to a corn snake. We also keep and breed both the Kalatoas and Madu Islands (Honey Island) forms, which are the next smallest of the commonly available SD localities. These typically do not grow larger than 2.4m (8ft) but are of a noticeably heavier build than those from the Korompa Islands.

Some of the animals we work with have been imported direct from a source in Indonesia whereas others have been acquired from other reticulated python breeders or collectors with an interest in these SD forms. ➤

➤ Assorted reticulated python morphs.

Indonesia consists of just over 17,500 islands – just 8844 are named, and only 922 are inhabited, according to the Indonesian government. Who knows if there could be other dwarf forms on some of the unexplored islands there?

A phantom tiger reticulated python.

Size matters

Q What size parameters do you expect them to stay within in collections, and do you think that the wild variants are only small due to a lack of bigger prey items in their home range? If so, will size be bred back into them?

A You're exactly right, John. The reason that these island forms have become dwarfed is due to a lack of larger prey items and/or a restricted availability of food in the wild. They are not simply stunted large reticulated pythons. Instead, they represent populations that have evolved naturally to be smaller over countless generations. It is effectively a genetic change now, rather than metabolic one.

In fact, this is typical of island species; there used to be miniature elephant populations on some of the Mediterranean islands for example! On the other hand, there are some famous exceptions to this rule, with certain species – such as the Komodo dragon or giant tortoises from the Galápagos Islands – actually becoming significantly larger rather than smaller.

Handling a phantom tiger reticulated python.

> **What has happened in the case of dwarf retics is down to environmentally-driven selection. This has resulted in smaller males**

What has happened in the case of dwarf retics is down to environmentally-driven selection. This has resulted in smaller males that require less sustenance to survive and yet can outcompete larger individuals who require more food. Almost certainly, they started to gain an upper hand in the survival stakes by being able to breed at an earlier age. So then generation after generation, smaller males triumphed in passing on their genes, resulting in a progressive reduction in the size of these particular island forms over many generations.

The largest pure super dwarf we have in our collection is only 2m (6.5ft) at seven years of age. Feeding is significant though, because obviously, if these animals are over-fed, then this extra food can cause them to grow larger, but more importantly

Dwarf toffee reticulated python.

perhaps, they will then become massively obese. Too much food will impact on their metabolism, shortening their lifespan and also seriously reducing the likelihood that they will breed successfully.

When you take into account that we are now breeding these small snakes after they have been scaled down naturally in the wild, where they were shaped literally by their environment, so keepers need to be sensible with the way that they feed and care for them. This is the only way that it will be possible to keep reducing their size further through selective breeding.

Colour morphs

Q There already seem to be quite a few colour variants within these new hatchlings. I guess these have come from crossing an SD individual with colour morph dwarf retics? Will this in itself limit the potential for size reduction?

A There is no reason to think that the mutations now to be seen in mainland reticulated pythons will not become available in the case of both the dwarf and super dwarf forms as well, in due course. However, this will require many generations of selective breeding of mutations into pure locality dwarf and super dwarf animals to be achieved.

We are currently underway with a project to do exactly that: we have a mainland tiger pied reticulated python that has been bred with a pure Madu and a pure Kalatoa super dwarf (SD). The offspring from these pairings will be 50% SD tiger het 100% pied, which, once grown on to sexual maturity, can produce a visual 50% SD tiger pied.

This snake in turn can then be bred back to a pure SD to produce 75% SD tiger 100% het pieds, and from this point, you can go on exponentially, right through until you end up with offspring which are 99% SD tiger pied, measuring a maximum of between 1.8-2.4m (6-8ft) in theory, depending on locality used. However, this would represent decades of selective breeding and requires a lot of outcrossing.

The time and commitment involved, combined with smaller clutch sizes, is why super dwarf reticulated python morphs with a higher percentage of super dwarf blood are so much more expensive and desirable than their mainland counterparts. They actually represent a better investment.

Feeding concerns

Q What do you feed the adults, what size of food and how often? Do you have to restrict the diet at all to maintain the size of these snakes?

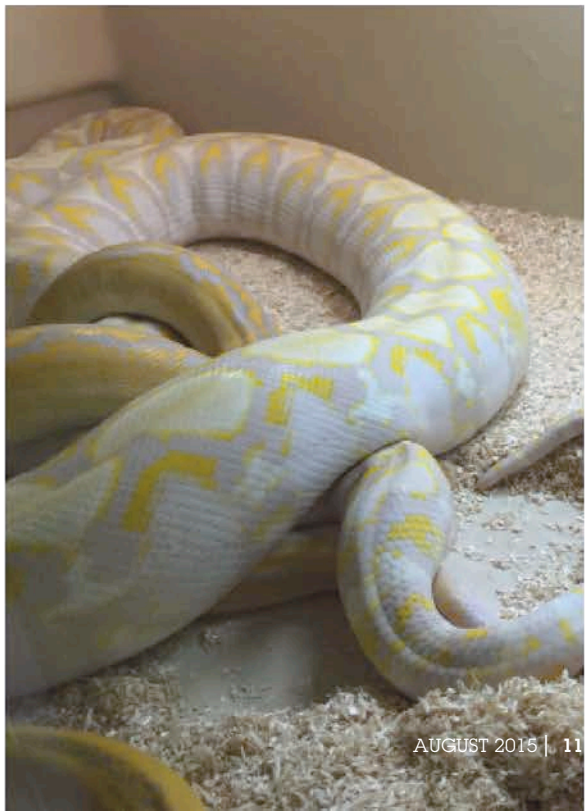
> **we have a mainland tiger pied reticulated python that has been bred with a pure Madu and a pure Kalatoa super dwarf (SD)**

▲ **A super dwarf lavender albino with eggs, in Eco Exotics' collection.**

▼ **An albino golden and a super dwarf lavender.**

A That is quite a difficult question to answer, because all of our adults have different feeding regimes dependent on their size, sex, the time of year, locality and the SD percentage of the bloodline. We believe it is essential to consider each snake individually, as no two animals are the same. As a result, we therefore have to design a bespoke nutrition plan for every individual that will meet its specific requirements.

However, as a general guide, whilst the ➤



animals are not being cooled or paired for breeding, we feed them every 7-10 days. Relatively speaking, we offer quite large meals in comparison to the size of the snake. As an example, a 1.8m (6ft) pure super dwarf will be fed with a rat weighing approximately 500g (1.1lb) every 7-10 days. This, typically speaking, leaves an evident bulge for 3-4 days.

I don't consider the way in which we feed our animals to be at all restrictive. I feel it is the correct way to cater for them, as it mimics a more natural way of feeding. After all, even the luckiest snake is not going to manage to have a large meal every week without fail for the whole of its life in the wild!

In our experience, it seems to be very difficult to grow super dwarf animals to over 2.4-2.7m (8-9ft) in length, regardless of heavy feeding. However, a mixed blood animal is more prone to growing significantly as the result of an excess of food, so in order to maintain a healthy size, sensible feeding is necessary.

I should stress again this is not simply to manage the size of the animal but also because large, overweight reticulated pythons are apathetic breeders. I believe allowing a snake to get into this state indicates an unhealthy animal that has not been fed and looked after correctly.

Breeding issues?

Q As with many high-end morphs of ball (royal) and indeed reticulated pythons themselves, have you seen any worrying physiological trends, such as the neurological symptoms that can be associated with the spider gene in ball pythons?

A We are quite lucky with the reticulated python mutations currently being bred, as the vast majority of them have no physiological defects at all, and as of now, there appear to be no "fatal genes" associated with these snakes either, which would impact on pairings.

The only common physiological issue that is well-recognised in reticulated pythons revolves around the digestive problems that can afflict leucistic individuals, but it appears that this can be overcome with the correct diet and feeding regime. Some of the early super tigers seemed to have an "odd" tongue flick that was thought perhaps to be a neurological issue.

Subsequent breeding programmes seem to have confirmed that this was not the case though, and instead, it was more than likely to have been an issue linked with inbreeding in those early days. I believe there have also been some reports of a few jaguar reticulated pythons having a head wobble similar to that associated with jaguar carpet pythons or a spider ball python. I have not seen this for myself, nor do I have a jaguar in my collection so I cannot verify with any certainty if this is the case or not.

➤ A stunning super dwarf purple reticulated python.

➤ An egg being candled, with the veins confirming that it is fertile.

One of Eco Exotics's super dwarfs hatching.

➤ A super dwarf egg alongside that of a ball (royal) python.

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A white phase super dwarf reticulated python.

Temperament

Q Do these snakes have the typical 'strike ready' tendencies of their larger relative or has the reduction in size made for a calmer animal?

A I have found super dwarfs to have as strong a feeding response as their mainland cousins. However, in order to manage this, we tap train all of our reticulated pythons in order to maintain them as safely as possible, with the welfare of both keeper and animal in mind. They soon recognise that when the door is being tapped, food is coming. This helps to prevent them launching at you indiscriminately whenever you put your hand inside their vivarium.

As far as handling goes, I have found captive bred reticulated pythons of all sizes to have very even temperaments. That said, you obviously have the odd animal that bucks the trend and is still a little fiery, yet these snakes just need to be managed with respect and handled with the correct demeanour, and they invariably tend to come round in no time at all.

Looking to the future

Q Where do you see the market for reticulated pythons in 5-10 years, and do you agree that there is a risk that many of the larger snakes of this species will have to be re-homed? Also, where do you think a reduction in size will stop, in the case of these snakes, before we see a detrimental impact on the species?

A Realistically speaking, the mainland reticulated python market is only going to be sustained through sensible selective breeding, and breeders working in tandem with one another to produce a manageable number of mainland animals.

➤ The "retic room" at Eco Exotics.

➤ A super dwarf lavender reticulated python hatching.

These can then be kept and enjoyed by experienced keepers, rather than the market being flooded with hundreds of cheap morphs that can ultimately exceed 2.74m (18ft) in length, and end up in the wrong hands because of their low cost and unscrupulous sellers.

I would very much like to see the future of reticulated pythons moving towards super dwarfs as they represent a much manageable size, nor can they produce 60+ eggs in a single clutch and therefore, the market is not going to become suddenly flooded with hundreds of snakes that nobody wants. Thanks to the hard work of a few breeders, super dwarf retics are becoming available in more mutations than ever before, helped by the fact that the price of some of the base morphs is becoming increasingly affordable. These factors mean that super dwarf reticulated pythons have never been more popular, but do buy with care, being sure that you obtain a snake of this type rather than ending up with a full-sized individual purchased at a premium price from an unscrupulous seller.

A baby graminea arboreal alligator lizard.

breed various colour variants is just a further massive bonus.

Environment and diet

Q You have fully implemented the 'wild re-creation' system for your groups, in terms of heat, light, energy from light and vivarium decoration. Arboreal alligator lizards represent a group that is very 'solar reliant', with the correct lighting being a major issue in their care. I also notice that you have used a digital control centre for each, to maintain precise environmental parameters. The one thing that is missing from all of our collections is, of course, a re-created wild diet. How easy is it to feed these lizards properly?

A Diet is a difficult subject, as obviously, the ideal would be to provide a fully balanced, varied diet that matches the multitude of prey species eaten in the wild – whatever that may be! We simply don't know, of course, and the range of insects commonly available in the UK just isn't broad enough to provide great choice. We use a variety of the typical feeder insects, and obviously gut load everything in order to ensure the lizards can derive maximum nutritional benefit from their prey.

Keeping alligator lizards

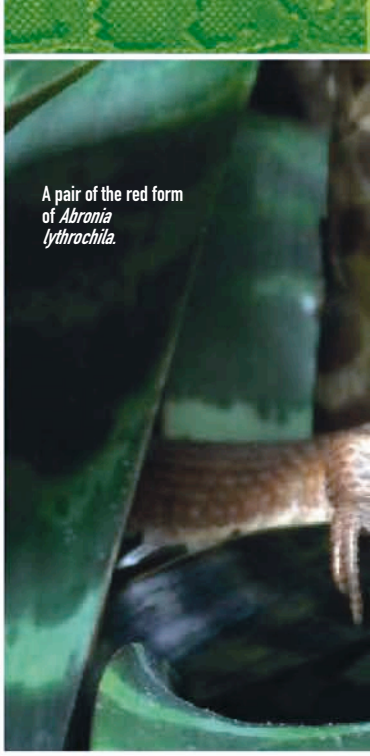
Q I have really enjoyed advising and helping you with your arboreal alligator lizards. These are incredible lizards and they represent a group of species that are very rare in the UK. What are your long terms goals for your group and how many defined species do you have?

A Members of the genus *Abronia* represent a really special genus of lizards and they have become one of our greatest passions. Our aim is to set up breeding groups of as many *Abronia* species as we can. We are currently keeping four species at the moment, in the form of *A. graminea*, *A. lythrochila*, *A. mixteca* and *A. taeniata*. We have, however, also located some *A. campbelli* and *A. vasconcelosii*, which should be joining our collection in the coming months.

In addition to the different species themselves, we are also working with a few rare colour phases; we have pinta *A. graminea*, which, rather than the classic aquamarine colour is gold. Then there is a red phase *A.lythrochila*. This, as the name might suggest, is a stunning red colour. Saying we are excited about the opportunity to breed a variety of *Abronia* species is an understatement, and the fact that we can also aim to

A female red lythrochila arboreal alligator lizard.

The colouration is quite pronounced on this red form of the lythrochila arboreal alligator lizard.



A pair of the red form of *Abronia lythrochila*.

Breeding success

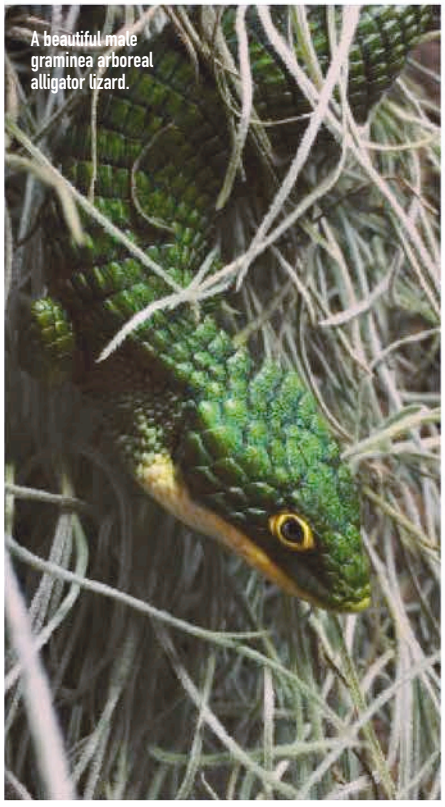
Q It is great to hear that you have already had some breeding success. Looking at wild data, arboreal alligator lizards have a very short breeding phase of just 2-3 months a year and produce relatively low numbers of live babies. This will of course be a limitation to the captive-bred population going forwards, but do you think that the seasons are set, or could they be slightly manipulated by providing a higher temperature, as well as altering the light exposure and humidity for example? Food may also be another factor of significance too?

A Thank you - yes, we're over the moon with the two litters that our lizards have had this season. I expect that as with most species, a certain amount of seasonal manipulation is possible with the correct tweaks to temperature, the number of daylight hours, light intensity and availability of food, to name just some factors that could be implicated. For the time being though, we will be sticking to what we know about these lizards, concentrating on their husbandry and looking at breeding success with them as a bonus. Collectively, we still have so much to learn about their needs and requirements.

I sincerely wish you well and I look forward to seeing both of these projects grow and develop. I am eagerly anticipating your arboreal alligator lizards becoming better-known and established in UK collections. I'm also excited by seeing some of these young super dwarf reticulated pythons once again as they grow older. Good luck!

A male mixteca arboreal alligator lizard.

A shedding female graminea.



A beautiful male graminea arboreal alligator lizard.

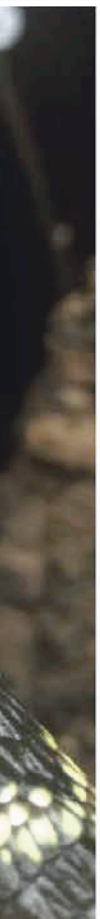
A male *Abronia taeniarta*.

Further information

Keep up-to-date with the very latest news from Eco Exotics through their Facebook page at https://www.facebook.com/pages/Eco-Exotics/1536623813289034

A male *Abronia mixteca.*

A male *Abronia mixteca.*



Yellow colouration around the eyes is a feature of *Abronia graminea.* A male is shown here.

A pair of grey lythrochilas in the Eco Exotics' collection.

A tortoise eating a dandelion leaf.
Photo courtesy of the author.

Wild foods for tortoises

Since they are herbivorous reptiles that are naturally inclined to browse, so it can sometimes be a challenge to supply tortoises with a suitably varied diet. But as explained last month, a range of cultivated plants can be purchased and propagated to provide nutritious food for them. In his second article, James Brereton focuses on wild plants that can also be used. As always, variety is of key importance: try to feed your tortoises with a wide range of different foods of this type!

Differences in diet

Tortoise, turtles and terrapins (collectively known as chelonians) have existed on the planet for over 200 million years. During this time, a range of different chelonian feeding habits have evolved, from the jellyfish-eating leatherback turtle (*Dermochelys coriacea*) to the strictly vegetarian desert tortoise (*Gopherus agassizii*).

This article will cover the dietary components needed by some of the more commonly kept herbivorous species. These typically include Horsfield's (*Agrionemys horsefieldii*), Hermann's (*Testudo hermanni*), the Mediterranean spur-thighed (*T. graeca*) and marginated (*T. marginata*) tortoises.

➤ **The feeding habits of tortoises can be quite variable. Those found in forests, such as the red-footed require more fruit in their diet.**

Other species are becoming more commonly bred, however, including the red-footed (*Chelonoidis carbonaria*) and yellow-footed (*C.denticulata*) tortoises: keep in mind these particular species do have different dietary requirements due to their rainforest origins, as may others. The large sulcata tortoises (*Centrochelys sulcata*) have a much higher fibre requirement than the aforementioned species, with grasses and good quality hay therefore making up a large component of their diet.

There are some excellent books and website that cover species-specific diets: the World Chelonian Trust's (2015) homepage, for example, contains care sheets for a wide range of different tortoises. Another site that is of particular interest is The Tortoise Table (2015), which displays plants that should (and shouldn't!) be fed to tortoises.

Dandelions

Dandelions (*Taraxacum officinale*) are very popular as a tortoise food. Both the leaves and flowers are eaten readily by herbivorous reptiles in general, and not just tortoises, with the nutritional value of dandelions being excellent for them. These plants are regarded as a high calcium food source, which is particularly

▲ When the weather is fine and warm, tropical tortoises will benefit from being outside, and foraging on a lawn.

important for our shelled reptiles.

Nutritional information about animal foods is normally hard to find. However, there are full nutritional analyses available for dandelion greens on the internet. The reason is that people have taken to eating the leaves of this plant as a healthy salad option, even cultivating it for this purpose.

An overall nutritional analysis can be found at the website SELFNutritionData (2015). In addition to high levels of calcium, the site also praises dandelions as a good source of vitamins A, C, and K. Nevertheless, always keep in mind that the nutritional values of particular plants will vary, depending on the soil quality, time of year and even the time of day, when it comes to drawing up such figures.

Nutritional value of dandelions (based on SELFNutritionData)

Amount per 55g serving	**Energy** (Kilojoules)
Calories	103 KJ
From carbohydrate	74.9 KJ
From fat	13.4 KJ
From protein	15.1 KJ

Sourcing

Dandelions can be found growing in fields, grassy verges, fields, by the roadside, and even in the narrow spaces between the paving slabs of patios. They have a great propensity to seed and thrive where gardeners do not require dandelions, which has earned them their weed status. However, they seem to favour sunny conditions over shade, so don't go looking for these plants in woodland. In warm, bright and moist conditions, dandelions can regenerate rapidly after having leaves plucked: just make sure only a few leaves are taken at a time, and keep the roots intact.

Garden dandelions are ideal and easily accessible, but as always with wild plants, if you do choose to harvest dandelions further afield, keep in mind pollution and pesticides. For example, avoid picking dandelions from the sides of roads, no matter how big or delectable these particular specimens may look.

The leaves are likely to be coated with carbon and exhaust fumes, and are therefore not suitable as reptile food. Furthermore, especially when picking leaves away from home, it's always worth washing everything before feeding it to your animals.

In short, dandelions are a sustainable, excellent food option for tortoises, and are available through the year from spring until late autumn. These plants die away as winter frosts set in, and unfortunately, attempts that I have made over the years to keep these plants inside during the winter have failed.

Cultivation

By growing dandelions on a bright windowsill though, it may be possible to achieve a limited supply throughout the year. If necessary, try chopping a root up into small segments about 2.5cm (1in) long, and set these in a pot, with the tops just protruding above the surface of the soil. They may then start to sprout. It is better to keep them in a plastic bag at first, to maintain the humidity until the leaves are growing well, but you do not want them to turn mouldly.

An almost fail-safe method of cultivating dandelions is by seed. Seeds, in the form of dandelion fuzz, can be kept if dry and planted during the next year. It is suggested that the germination of dandelions is more successful if the seeds are cooled for a period – for example, in the fridge.

▲ Be careful where you gather dandelions growing in the wild.

Dandelion seeds disperse readily in the breeze. You can collect them easily by placing a paper bag over a ripe seed head, turning the stem of the seed head downwards and cutting through it with your finger, enabling the seeds to be contained within the bag.

In any case, dandelion cultivation may not be entirely necessary. These so-called 'weeds' reappear every year, and you may not need to plant any to get a good crop each spring, although they often become harder to find in high summer, if the weather is dry for any length of time.

Clover

Clover is a component of grassy fields, meadows and lawns, but this plant is often difficult to spot without looking closely, except during the flowering season. The typical lawn clover (*Trifolium repens*) has small, white flowers, and is favoured by many species of tortoise. When marching across the garden, these animals will often stop to bite selectively at these flowers as they emerge, and readily recognise the characteristic three-leaved appearance of white clover as well. Flowers will emerge even in a ➤

▼ Dandelions are a common sight in gardens, often growing where they are not wanted!

White clover has quite a compact pattern of growth, certainly when compared with its red relative.

well-mown lawn, but better growths of these flowers appear in wilder spots. Red clover (*Trifolium pratense*) is more of a vibrant purple colour than red when in flower, with this plant being found in hedgerows and undergrowth. It is described as a perennial, short-lived plant, and dies back each winter, before re-emerging in the spring for a few years.

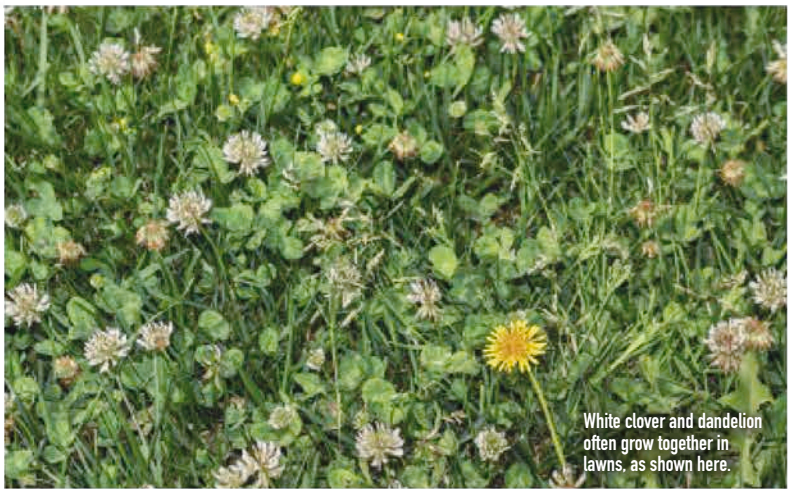
The stalks of this plant are much taller than white clover: red clover typically grows from 20-80cm (8-32in) in height. The flowers, too, are considerably larger than white clover blooms: these blooms take awhile to be eaten by tortoises. The reptiles tend to remove the petals selectively, leaving the fleshy bulb of the flower uneaten.

Both white and red clover can be purchased as seeds from specialist suppliers – some people keep clover lawns, as they don't need trimming. Check the seed racks in garden centres too: red clover seeds may occasionally appear there. White clover often crops up naturally as a component of your lawn, so you don't need specialist seeds to obtain this plant. It is surprising what a variety of plants may develop here alongside the grass itself over time.

Plantain

The broadleaf plantain (*Plantago major*) is a common sight in fields, meadows, and the cracks between pavement slabs. It too can become established in lawns as well. Plantain can be found in many modified ecosystems, and is tolerant to being trampled on, thanks to the flattened profile of its leaves.

Red clover grows quite tall, and produces an unmistakeable flower, that often attracts bees. Note the shape of the foliage too.



White clover and dandelion often grow together in lawns, as shown here.

Since the 1500s, plantain has been eaten on account of its purported medicinal properties, which are said to range from wound healing to improving liver function. Interestingly enough, Shakespeare mentions the plant in several of his plays. Furthermore, it has been claimed that tea made from plantain leaves has even been used to soothe sore throats successfully.

Plantain is a perennial, so there will be a stock of leaves for several years if the plant is treated properly. In terms of propagation, plantain produces seeds, which can be sown into the ground or lawn. You can purchase large quantities of plantain seeds online: they're sold as a bird seed!

However, keep in mind when sowing

▲ Wide leaves and raised flower spikes are a feature of broadleaf plantain, although in a lawn that is regularly mowed, only the leaves are likely to be evident.

these plants that the plantain is a weed, and incredibly successful at thriving, so if it becomes established in your lawn, it will be hard to eliminate, especially as you will not be able to use any weed killers where tortoises are browsing. You may prefer, therefore, to sow some seed in a tub, where the plants are contained, and pick the leaves for your pets. You can obviously do the same with clover and dandelion too.

Mature plantain leaves contain tough fibres that may be difficult for your tortoise to bite through. However, the abrasive action of gnawing may help to keep the beak worn down. As always, there's little tangible nutritional data on plantain leaves, in spite of the fact that there is a plethora of journals and books covering the purported medicinal properties of this plant.

Plantain does, however, grow rapidly. From sowing the seed to having plants ready for harvest will take about thirty days. This hardy weed can survive in full sun and shade. If grown in pots, the plants can be kept indoors throughout the winter, giving you an additional option for your tortoise's winter diet. This is particularly useful for small tortoises that will not hibernate for as long over this period, and so will require feeding.

Watercress

This deep-green plant is more frequently seen in bags in supermarkets than in the wild, but it does exist in a wild state in Britain. Watercress (*Nasturtium officinale*) may be found growing on the edges of slow-flowing rivers and streams, and has a very recognisable appearance. This probably is not a plant that will naturally spread into your garden therefore.

As a human foodstuff, watercress has been nutritionally analysed multiple times: check any supermarket bag, and you'll find the breakdown here. It is notable for being rich in iron, as well as calcium and various vitamins, including vitamin A. To grow watercress, buy a bag from your local supermarket, and soak the base of several stems in water. Over the course of a week, roots should develop: the plants can then be planted in moist soil.

Watercress is a little more complicated to cultivate than, say, dandelions, but it's worth the effort. The plant should be watered frequently and well, but the soil needs to be able to drain too. Keeping the plant in a pot is therefore recommended. Six to seven hours of natural light per day is the suggested allowance, so think carefully about where you intend to put the pot. It is also possible to buy watercress seed, if you are feeling more adventurous.

▲ Watercress seedlings being grown.

Thistles – or not!

Plants such as the Scotch thistle (*Onopordum acanthium*) grow rapidly and can be spiky to handle. Some tortoises may eat the leaves of this plant: new growth tends to produce softer leaves, which can be more palatable and recommended, as they are less likely to cause any injury in the tortoise's mouth or gullet.

It may become a question of preference as some tortoises are simply not interested in trying thistle plants. If you want to find out whether yours will, offer thistle to your tortoise several times, and see whether it has any interest in eating the plant. After all, variety is vital to protect against vitamin or mineral deficiencies! Even if your tortoise does not want to eat it, at least you should have ➤

▼ This a different form of plantain that tortoises also enjoy, called ribwort plantain (*Plantago lanceolata*), with elongated leaves and a shorter flower spike.

Watercress growing in the wild. It must have moist conditions.

an attractive, tall, architectural plant growing in your border.

Rather confusingly, common sow thistles (*Soncus oleraceus*), which are a popular food with Mediterranean tortoises, are actually not thistles at all, but close relatives of dandelions. They can have slightly spiky edging to their leaves, which is more pronounced in some species than others and accounts for their common name. Sow thistles can be grown in a similar way to dandelions, but it helps to pick the main stem on occasions, so as to encourage the development of side shoots.

➤ **Sow thistle has multiple small flowers, rather than a larger single flower on a stalk like a dandelion, and grows much taller as well.**

Cuttlefish

Ok, so this obviously isn't a plant! The "bone" of the cuttlefish (*Sepia spp.*) is a white, crunchy, oval-shaped object that appears on beaches at certain times of year, most commonly in the autumn and winter following storms. It is actually a buoyancy aid, rather than a bone, with cuttlefish being invertebrates.

If you find these bones, be sure there is no flesh attached, and then soak them at home in a bucket of water for a couple of weeks, changing this every daily. Finally, allow the bones to dry thoroughly, in an oven on low heat if necessary. Once thoroughly dried, they can then be stored in a clean paper bag for later use.

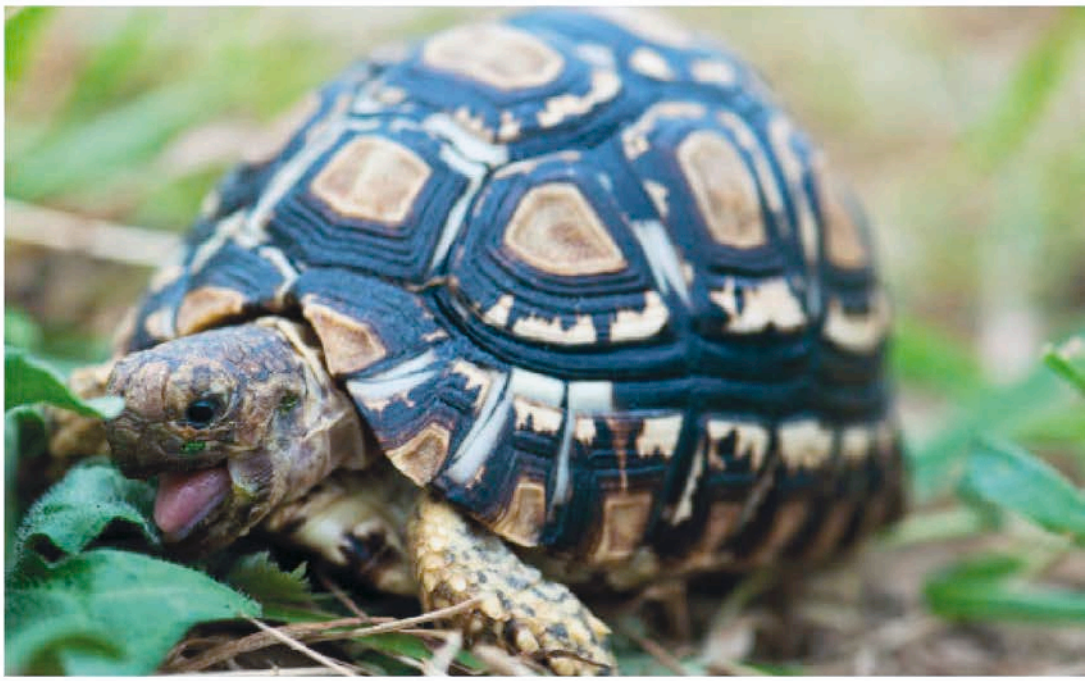
The so-called beak of a tortoise can become overgrown and ultimately distorted. This may be linked to a lack of hard surfaces, preventing the reptile from wearing down this part of the jaws, which are used to slice through plant matter. Photo courtesy the author.

For those who don't live near the coast, cuttlefish bone is readily available online and in pet shops, where it is more typically sold for budgerigars and other pet birds. The 'bone' is rich in calcium and easy for a tortoise to bite small chunks from. These may be added to indoor and outdoor enclosures, allowing tortoises to increase their calcium intake when they require.

Another rich form of calcium is chalk, which can be found in chalk cliffs and the ground in some areas of the UK. Chalk is a much harder substance than cuttlefish bone, and may be consumed less often. However, some tortoises do gnaw on small pieces of chalk: this relatively tough material may again help to keep the beak worn down.

Tortoises have a high requirement for calcium and adding an area of crushed chalk in their enclosure can be beneficial. This is particularly important when they are grazing during the summer, as using a supplement then is more difficult. Furthermore, you can use crushed chalk to add to the décor within an enclosure: make a chalk figure in your tortoise's pen, for example!

➤ **Tasty young leaves will soon be out of reach, given the height to which this plant grows.**



What not to feed

Luckily, tortoises tend to display a keen, innate sense of survival when allowed outside to roam in a garden. They will generally avoid plants that could be harmful to them, particularly when there is a good supply of other food such as dandelions available to them.

Nevertheless, there are lists of potentially harmful plants that have been drawn up, but often, these are extrapolated from lists relating to mammalian herbivores in general, rather than reptiles in the form of tortoises in particular.

There is generally no need to comb the area of your lawn where your tortoise is grazing, and trying to dig up plants that may be a problem. If food is getting short in high summer, when a combination of heat and relatively little rain impose a check on the growth of plants such as dandelions, provide other safe alternatives as a supplementary source of food. You can also sprinkle a nutritional supplement over this food as well.

Always bear in mind that tortoises are most likely to eat potentially harmful plants when they are hungry, and buttercups (*Ranunculus repens*) can become more of a problem at this stage. They can spread quite rapidly through a lawn as well, particularly in shady areas, and have attractive yellow flowers that tortoises like.

While the odd nibble of this plant will not be harmful, it is worth remembering that perhaps the only confirmed case of a death of a tortoise as the result of plant poisoning on record involved buttercups. The owners had unwittingly been feeding their pet on large numbers of these flowers, without realising that buttercups are potentially deadly. It pays to be cautious, and simply stick to offering foods to your tortoise that are known to be safe.

In summary

Whether in your back garden or collected elsewhere where it is safe to do so, many weeds and wild plants can make a vital contribution to your tortoise's diet. From the calcium-rich dandelion to sought-after clover flowers, these plants may be encouraged to grow in the surroundings of your garden, allowing you to cut down your dependence on shop-bought food for your pet. Fresh, home-grown food is also likely to have a higher vitamin content too, adding to its benefits.

This article has, of course, only covered a tiny fraction of the variety of plants that are suitable as food for tortoises. If you are interested in learning more, websites such as The Tortoise Table can offer very comprehensive lists based on years of experience. Build up your collection of tortoise plants and weeds, and you can offer natural foraging opportunities for your reptile while it enjoys time outdoors during the brief British summer. You can even buy specifically formulated seed mixes produced by the likes of ProRep to create an individual, small-scale wild flower meadow for your tortoise. ✣

➤ **Healthy tortoises, like this leopard tortoise seen eating dandelion leaves, have large appetites.**

➤ **Buttercups can be seen growing here as part of a mixed sward, alongside red clover and plantain. The buttercups will normally be generally ignored by the tortoises.** Photo courtesy of the author.

➤ **A leopard tortoise called Tanker, tucking into cuttlefish bone.** Photo by Catherine from Stockport.

Further information

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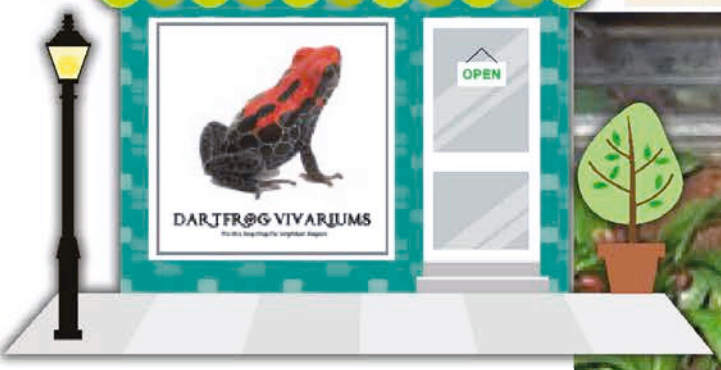
SHOP PROFILE

Featured this month

DARTFROG VIVARIUMS



All photos courtesy Roland Sayer/Dartfrog Vivariums.

This month, we profile Dartfrog Vivariums, based in Bulwell, Nottinghamshire.

Dartfrog Vivariums was established during the summer of 2013, by its owner Roland Sayer. He had always been a keen aquatic and amphibian hobbyist since childhood, with his particular passion being the creation of natural, realistic and ecologically balanced environments for all of his animals.

So how did the business come into being? "During my final couple of years serving in the Royal Air Force, I sat back and looked at what I wanted to do for the rest of my life," explains Roland. "Was I going to return to my old trade of horticulture, for which I was fully qualified, or should I continue in logistics, which is what I done for the last 12 years in the air force?"

Following a new path

A small event then changed his life. One weekend, Roland was ordering items for a new vivarium that he was setting up for his green and black poison dart frogs (*Dendrobates auratus*), and was disappointed by the limited range of items on offer.

"It then dawned on me that I would not be the only dart frog keeper frustrated by this situation. I could possibly develop this as a business, acquiring such items and helping fellow hobbyists to breed their animals more successfully. So I started researching the trade within the UK," says Roland. "I began to attend more breeder shows, as well as speaking direct to owners of pet and reptile shops throughout the UK, so as to gauge what people wanted.

"It soon became evident that there was indeed interest in setting up natural, realistic enclosures. Demand in this area was growing, but retailers were finding it hard or even nearly impossible to buy specialised, amphibian-related products within the UK, especially plants that could be guaranteed to be safe for use in a vivarium," he explains.

According to Roland, the situation was so bad, with just a couple of companies in the UK catering for the market but not in a comprehensive way, that customers were being forced to buy what they needed from overseas as a result. They were finding themselves being dependent on buying from Europe and America and paying high shipping costs, and often import duties as well in the case of US purchases.

As a result of these findings, Roland felt that it could be possible to combine his passions both as a amphibian keeper and a horticulturist, to create a fully fledged business supplying everything the general public and trade customers could possibly need for their amphibians. This would range from natural products and plants to custom vivariums and euro-racking at a realistic price.

Getting things underway

Dartfrog Vivariums Ltd therefore came into existence, but it proved to be much harder to source the items than Roland had initially thought would be the case. "There was no individual supplier who could meet all my needs," he says. "So I turned to some of my horticultural contacts. This ultimately meant that I was able to persuade one of the largest plant suppliers in Holland to supply products to us directly.

"This was a major breakthrough, and gave us the flexibility to start trading online, as well as at breeder shows and other events throughout the UK. It also helped us to pass on large savings to our customers, by dramatically reducing what they paid for their plants. It also gave us more flexibility in the choice of plants that we could offer, and I think the combination of these factors has helped to expand the market too."

Roland continues: "It soon became clear that customers wanted a 'one-stop' shop. So based on their needs, we created a Top 100 products list to meet demand. It includes everything from live food, pods and vines to misting systems and customised vivariums.

"With this in hand, we then proceeded to find and talk with suppliers all over the world, to allow us to meet our requirements. We now offer an unrivalled range of products for people wanting to construct and maintain their own naturalistic vivariums, and we can also undertake custom-builds of planted enclosures for our customers as well." ✥

Find out more

Website: www.dartfrog-vivariums.co.uk
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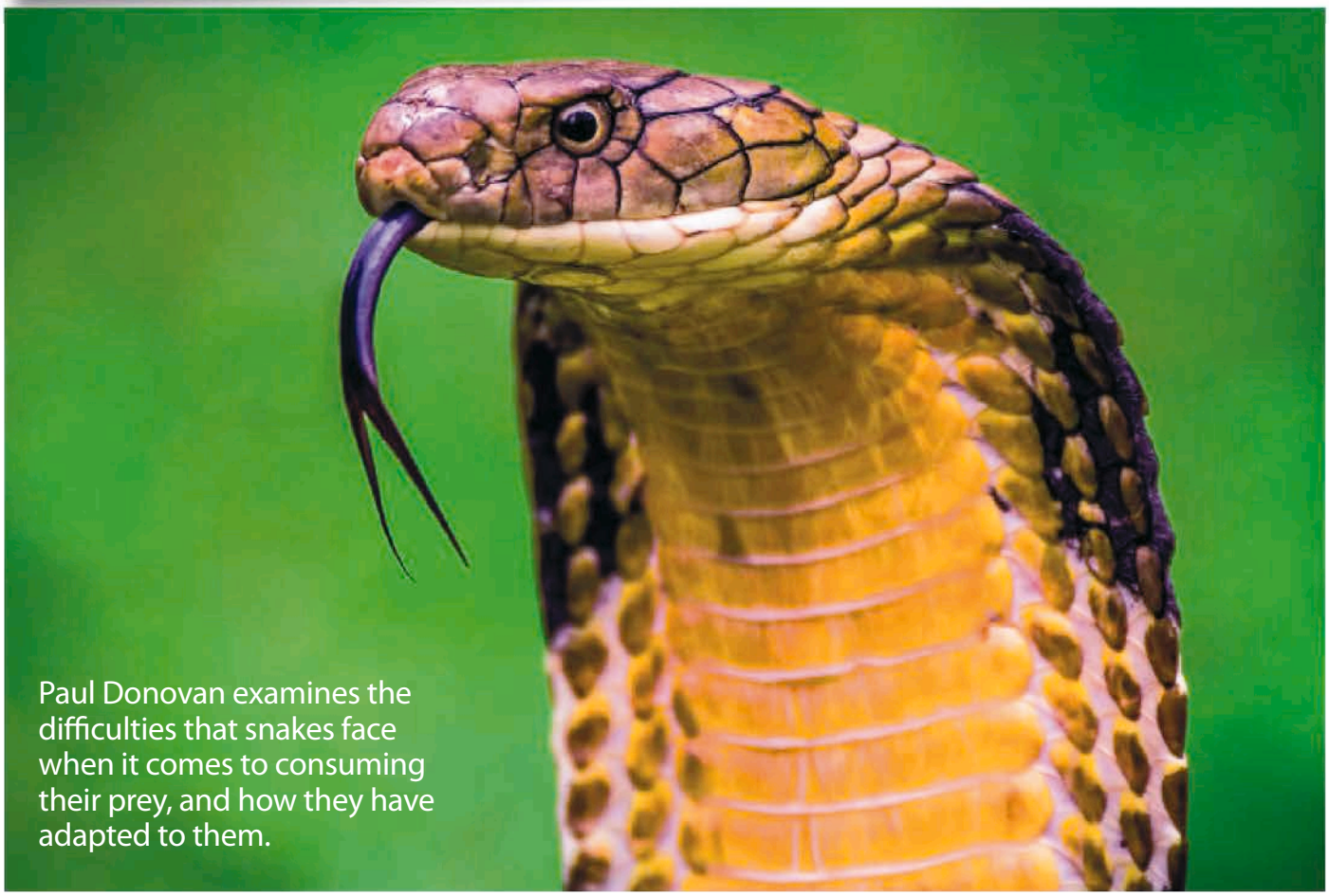
Out of Africa



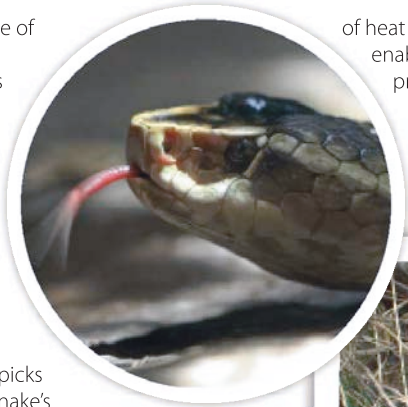
Paul Donovan examines the difficulties that snakes face when it comes to consuming their prey, and how they have adapted to them.

The problems with eating

Snakes hunt their food in one of two ways. They either lie in wait for it and ambush it, as puff adders do, or they actively go on the hunt for it, which is the technique favoured by cobras. Prey is detected through the chemical scents that it produces, which the snake encounters on the tip of its forked tongue.

The continual flicking of the tongue in and out of the mouth picks up airborne molecules that the snake's brain translates into positive or negative messages. A snake is capable of following the trail left by an animal for some considerable distance, following every twist and turn that its potential prey makes.

Such odours register via an organ in the roof of the mouth called the Jacobson's organ, are converted to nerve impulses and interpreted by the brain. Alternatively, quarry may be detected through visual perception or with the aid of heat sensing pits around the jaws, enabling a snake literally to "see" its prey, even in total darkness.



➤ The movements of the snake's tongue help to detect the scent of prey in its vicinity. An eastern cottonmouth is seen here.

Well-adapted for survival

In some ways, snakes can be regarded as opportunistic feeders, because they take food as and when it is available. However, while there may be rodents within the area where a snake is present, if the reptile is not hungry, then they will be ignored.

Equally, again, if the snake perceives the animal to be too large, it will also be left alone; what is the use of expending

➤ Puff adders are very effectively camouflaged, which makes them lethal as ambush predators when unwary prey ventures within reach. Photo courtesy of the author.

➤ **Snakes may live in localities with rodents. The eastern indigo snake *(Drymarchon couperi)*, for example, may be encountered in gopher tortoise burrows alongside a variety of rodents, but only hunts them when it is hungry.**

energy, valuable venom reserves and putting yourself at potential risk of injury if there is nothing is to be gained from it? Snakes do not wantonly kill simply for the sake of it. They only do so to feed or defend themselves.

Snakes cannot be described as 'greedy' feeders either. They will not take everything that they come across, at every available opportunity. This characteristic is frequently displayed during hibernation, when snakes and mammals may cohabit together in the same retreat.

Furthermore, because of the snake's relatively slow metabolism in relation to the size of its prey and the energy that is gained from it, it is not necessary for the snake to feed every day, every week, or every month come to that.

Depending on the snake's level of activity, a good-sized meal could sustain a snake for several months, if not longer. During my formative years as a trainee reptile keeper, the first zoological collection where I worked had a very large green anaconda. This particular snake would feed just every six months on two rabbits at a time.

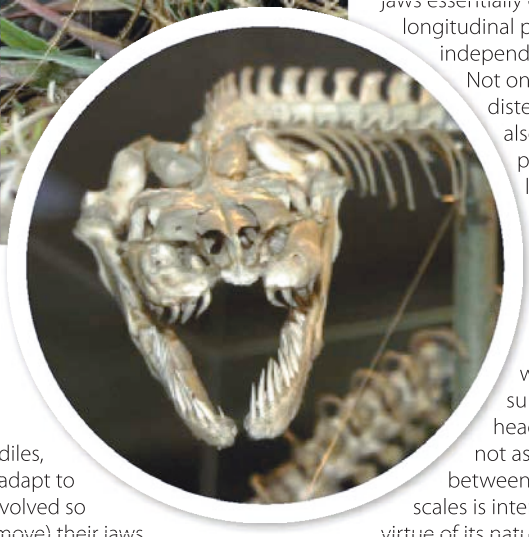
Swallowing

Once the prey has been killed, either through the use of venom or constriction, the snake must then begin to swallow it. The tongue will flick over the body until the head is located before the process of swallowing begins.

It is easier to swallow an animal following the direction of the fur, rather than going against it, although some individuals do take the hard route sometimes, tail first! But how does a snake manage to swallow something that is often significantly larger not only than its head, but also its body as well?

Elastic jaws

Since a snake lacks the ability to reduce its prey down to a size that can be easily ingested, by biting off chunks or even tearing it apart like crocodiles, then its only option is to adapt to swallow it. Snakes have evolved so that they can articulate (move) their jaws to enable them to swallow prey significantly larger than the girth of their head or body; remarkably, in some cases, this may be up to five times this figure overall. Just imagine trying to cram a leg of beef five times the width of your head into your mouth! Yet that is what snakes are able to do on a routine basis.



➤ **A snake's teeth help to hold on to the prey, with their sharp tips and backward-pointing profile, but cannot dismember it.**

The ability to swallow large prey is dependent upon several factors operating together - notably the elasticity of the ligaments which connect the bones of the lower jaw; the mobility of the upper jaws, and the shape of the teeth. The upper and lower jaws essentially consist of four longitudinal parts that can work independently from one another. Not only can the lower jaw distend downwards, but also sideways. This is made possible due to ligaments that 'attach' the bones together at the front.

Of course, it is all well and good having elasticised jaws, but the prey being swallowed would not get far if the surrounding skin of the head, neck and body were not as elastic. Therefore, between each of the snake's scales is interstitial skin, which, by virtue of its nature, allows this part of the body to stretch. Every connection may only be relatively small, but collectively, the result is significant. It increases the diameter of the body, allowing the snake's food to track its way down gradually into the stomach. ➤

➤ **Venomous snakes like this rattlesnake, with droplets of venom at the tips of its fangs, are very much in the minority. There are only about 600 species of snake worldwide that produce venom, out of a total of 3400, and just 200 represent any sort of threat to people.**

Anacondas – like other snakes – can open their mouths to an angle of almost 180 degrees, to help them swallow prey.

Problems with breathing

The capacity to distend the jaws in order to facilitate the swallowing of meals of seemingly impossible size exposes the snake to one major danger - the threat of suffocation. Trying to swallow something larger than you are places great pressure on the windpipe, which runs close to the gullet. There is even the possibly of actually crushing and blocking it, which would seal out the air and thus prevent the snake from breathing.

In order to eliminate this risk, however, the windpipe can be protruded from the snake's mouth, in a way just like a snorkel, so that breathing is not impeded. In addition, because the windpipe is reinforced with rings of cartilage, which provide some support, so these give it a degree of rigidity and help to prevent it from collapsing under pressure. When the meal enters the neck region on its journey to the snake' stomach, the windpipe is then retracted - a bit like a telescope.

Things can go wrong

Although capable of eating large prey, there is a limit to what can be ingested safely. There are numerous stories of large pythons swallowing antelopes, only for the horns of their prey to pierce the snake's body cavity. In such situations, because the animal was eaten head first, the reptile is incapable of regurgitating its quarry and will eventually succumb to its injuries, resulting in a slow, painful death.

Likewise, once digestion has begun, the skin around the animal will become tight and rigid, and there is no flexibility. As gases in the stomach build-up, so the pressure on the stomach may become so great that the snake has no option other than to regurgitate its quarry, after having managed to overcome and swallow it successfully.

Note how the skin has expanded around the scales here, in the case of this Sierra garter snake *(Thamnophis couchi)*, as it starts to swallow this fish.

Furthermore, excessively large prey can also create problems later on during the digestive process. It can begin to rot in the snake's stomach because there are insufficient digestive juices to break it down fast enough in this environment.

The associated build-up of toxins, combined with pressure on the wall of the stomach will be detrimental to the snake. These factors will once again lead to the snake's prey being regurgitated.

It should also not be forgotten that during the digestive process, the snake is vulnerable to attack, and it would normally seek out somewhere quiet to digest its meal. If the prey item is so large that the snake is unable to move and find security however, it must remain where it is, probably out in the open, vulnerable and at risk of harm.

Beyond the realms of possibility?

Since the early European explorers set foot in South America, which is the home of the green anaconda (*Enectues murinus*), stories of giant snakes

The width of this toad's body is clearly much broader than that of the body of the grass snake that has caught it and is now beginning to swallow it. Capturing prey headfirst makes this process easier though, even in the absence of fur or feathers.

devouring humans have been perpetuated, initially in Victorian journals. Even today, fanciful stories still persist, frequently surfacing online now, although the evidence to back them up is still woefully lacking. Here in Botswana too, giant African rock pythons (*Python sebae*) are often blamed in the press for having eaten people, even though the offending snake is never found!

There is little doubt that the green anaconda, reticulated python (*Python reticulatus*), Burmese python (*Python molurus*) or the African rock python grow to sizes where they could eat a small child. But an adult human? Come on! That has to be fiction that should be left to Hollywood directors, and those who post fake pictures on the Internet. Not everyone agrees with this view though…

The latest investigation

The subject of whether large snakes can eat people was in the news at the end of last year when naturalist Paul Rosolie and a team decided to investigate this suggestion in the most dramatic way possible. They tracked down a green anaconda measuring 6m (20ft) long and weighing 114kg (18st), near the headwaters of the Amazon, although their target had been an even bigger anaconda, nicknamed locally as Chumana. This particular snake was said to be over 7.3m (24ft) long.

Wearing a specially designed carbon fibre suit, to protect him from being crushed, suffocated or attacked by the snake's stomach acid, and covered in pigs' blood, Rosolie then sought to persuade the snake to swallow him. This bizarre and controversial event was filmed for a documentary entitled *Eaten Alive*, broadcast on the Discovery Channel.

▲ A large anaconda encountered in the wilds of Peru.

However, the experiment only got as far as the snake swallowing the intrepid explorer's head, because he feared it was breaking his arm. This led to the experiment being called off after an hour, before it could be discovered as to whether or not the anaconda could manage to ingest Paul Rosolie's shoulders and the rest of his body.

Varied diet

While popular attention may be focused on the feeding habits of the giants of the group, snakes actually display tremendous diversity in the range of prey species that make up their diet. Far from feeding exclusively on rodents and birds, which are eaten by the majority of species, there are also many examples of specialised feeders within this group of reptiles.

The king cobra (*Ophiophagus hannah*), ➤

▼An African python swallowing a gazelle. During this process, the shape of this antelope is apparent in the snake's body, but then afterwards, there is simply a bulge in its body, showing it has fed recently.

The king cobra is a species that hunts other snakes.

for example, is described as being ophiophagous, feeding wholly on other snakes. Even the widely-kept king snakes (*Lampropeltis* species) can display this behaviour, being known to prey on occasions on rattlesnakes in the wild.

Then there is the tiger snake (*Notechis scutellatus*), a species that feeds mainly on frogs, as well as the fishing snake (*Erpeton tentaculatus*) and pelagic sea snake (*Pelamis platurus*) that hunt fish. In addition, the meadow or Ursini's viper (*Vipera ursini*) is an example of an insectivorous species.

There are other, ever more specialised hunters. These include the African egg-eating snakes (*Dasypeltis* species) that feed exclusively on birds' eggs, being specially adapted for this purpose. Projections from the spine of these snakes act like a saw collapsing the shell of the egg and releasing its contents of the egg into the intestinal tract, before the shell is regurgitated.

Then there is the common slug-eater (*Duberria lutrix*) that feeds exclusively on slugs. Centipede snakes (*Aparallactus species*) seek out centipedes and have had to develop some immunity to the poisonous bite of these aggressive arthropods. And there is even a specialised crab eater, known to science as *Fordonia leucobalia*.

This crab-eating water snake hails from South-east Asia, Papua New Guinea and northern parts of Australia. It is a rear-fanged snake, possessing a particular venom that is deadly to crabs. Interestingly, in this case, once the crab is dead, the snake actually proceeds to detach the crustacean's legs before consuming its body.

Both techniques - specialisation of this type and the versatility of being able to switch between different food sources which typifies many snakes - have enabled this group of reptiles to become highly successful, establishing very distinctive niches in the natural world.

➤ Ursini's viper hunts invertebrates.

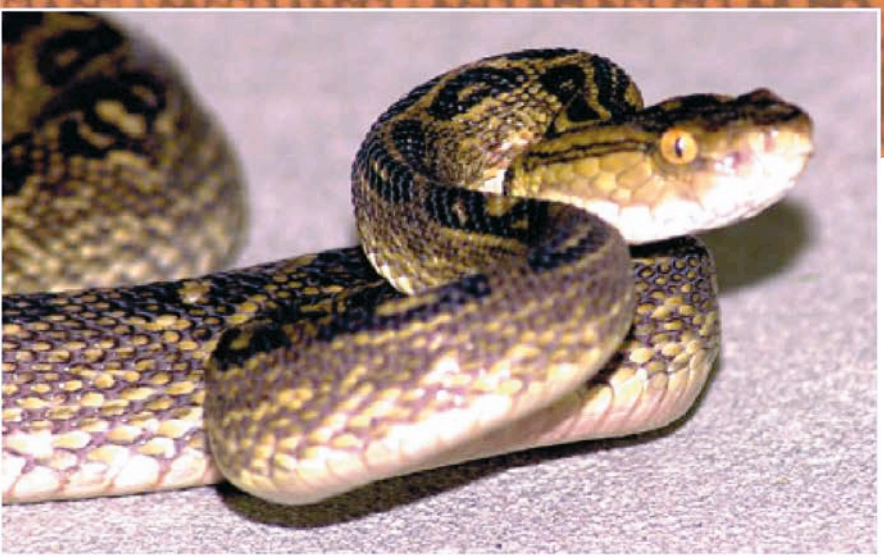
➤ A Cape centipede snake *(Aparallactus capensis)* is a very specialised hunter, preying exclusively on these invertebrates. Photo courtesy of the author.

Going without food

Snakes are well-known for their ability to go without food for considerable lengths of time, and this can clearly aid their survival when times are tough and prey is in short supply. The cascabel or South American rattlesnake (*Crotalus durissus*), for example, is known to fast for anything up to 26 months. However, the species that is known to fast probably longer than any other snake is the habu (*Trimeresurus flavoviridis*), which is found on the Ryukyu Islands, near Japan.

In fact, a particularly cruel experiment was performed at the Amami Kanko Pit Viper Centre, Naze City, Kagoshima Prefecture in Japan, starting on the 10th September 1977, to see just how long these snakes could go without food before dying of starvation. Five of them were kept strictly without food. The first member of the group died on the 207th day; the second on the 696th day; the third on the 1101st

➤ The cascabel is a species well-adapted to fasting.



➤ **The habu is known for its ability to survive years without food.** Photo copyright US government/ US Marine Corps/source PD.

➤ **A common egg-eating snake having swallowed the egg successfully.** Photo courtesy Mond76/PD.

day, more than three years after these snakes had last eaten, and a fourth on the 1184th day.

The fifth survived for 1189 days and this was when the experiment was called to a close. This remaining individual was gradually nursed back to a healthy state and ultimately appeared none the worst for its experience. One interesting fact that the researchers discovered was that it actually increased in length during its fast, indicating that it had carried on growing.

Carrion

It was once widely accepted that snakes were not carrion eaters. However, more recent observations have dispelled this belief as a myth. The observation of a cottonmouth (*Agkistrodon piscivorous*) consuming a dead water snake (*Nerodia erythrogaster*) was quite amazing.

But this was not as remarkable as a prairie rattlesnake (*Crotalus viridis*) that was witnessed eating a long-dead cottontail rabbit - complete with maggots! On a personal note, I once stumbled across a Mozambique spitting cobra (*Naja mossambica*) attempting to eat a rather dry, desiccated frog.

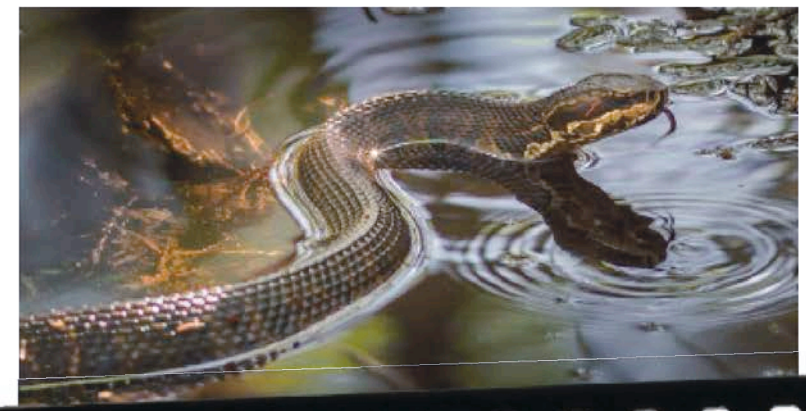
Certainly from my experience based on keeping venomous snakes, I have found many species willingly take food without that initial strike and envenomating process. In particular, I had a trio of red diamondback rattlesnakes (*Crotalus ruber*) that would not strike at the items being offered (which were dead rats in this case), but simply took their food after it had been left on the cage floor. Even more unusual was the fact that one individual would only eat if the rats had been in the cage for 24 hours, by which time they would be smelling rather unpleasant!

It is difficult to say whether these examples were isolated instances, or carrion feeding in snakes is more widespread than we imagine. What they do illustrate, however, is the adaptability of snakes in times of need to resort to eating food that they would normally ignore. Although we are led to believe snakes only respond to living, or at least moving, prey, these examples clearly call this belief into doubt under certain circumstances.

Tail-end

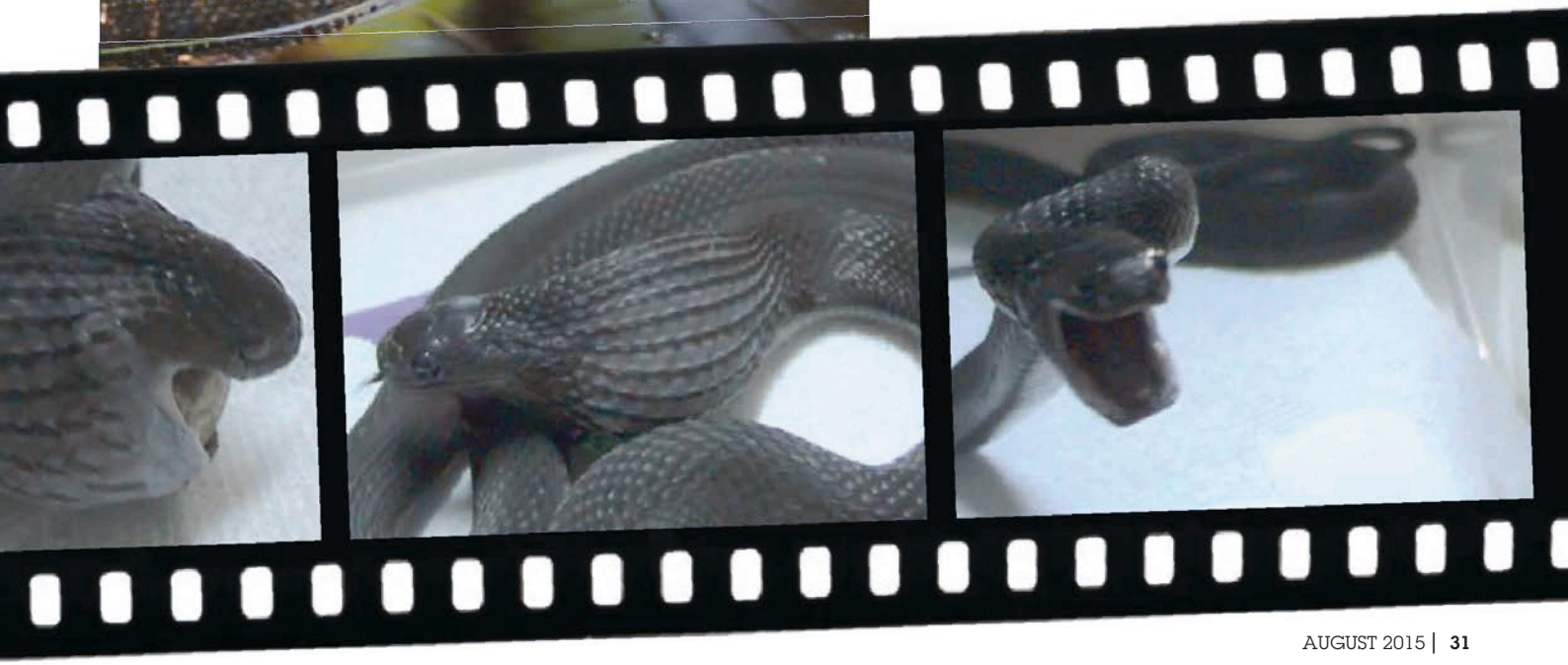
Snakes have evolved a unique approach to tackling prey that is larger than themselves. Their lack of limbs, and the absence of any ability to reduce large quarry into manageable mouth-sized portions, has far from hindered the snakes' capacity to hunt effectively.

They can feed on just about every kind of animal from invertebrates, fish, amphibians, birds and their eggs plus mammals through to their own kind and indeed, other reptiles as well. This has undoubtedly helped them to become a very successful group, represented on all continents today, apart from Antarctica where the temperature alone would preclude their survival. ✣



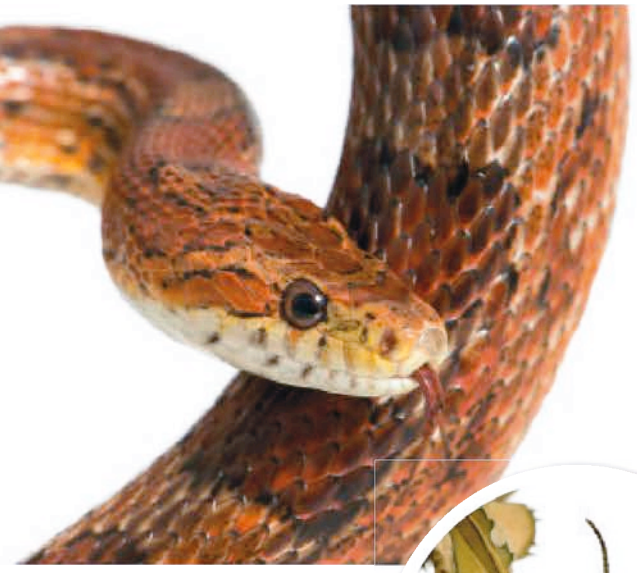
➤ **The North American cottonmouth snake has been observed scavenging food in the wild.**

➤ **An egg-eating snake (*Dasypeltis atra*) consuming a quail's egg, before spitting out the shell.** Photos courtesy Dawson at English Wikipedia.



Visit The Pet Show!

There's a great opportunity for a fun day out for all the family, enjoying the company of pets of all types, at The Pet Show. This event is taking place over the weekend of the 1st and 2nd of August at Stoneleigh Park in Warwickshire. Aside from reptiles, you can see a wide range of other animals too, including horses, dogs, cats, birds and small furry pets!



It is easy to find your way around at the event, with each section of the show being cleared named and signposted. Unsurprisingly, reptiles can be found in The Vivarium section!

If you're thinking of acquiring your first pet reptile, and are looking for someone to talk with, who can advise on what might be the best choice for you, then be sure to seek the advice of one of a team of experts here. They will be more than happy to talk you through the options.

You can also get up close and personal with some of reptiles on display, which should help you to reach your decision.

The Reptile Education Zone is being run in conjunction with The British Herpetological Society, with the overall aim of providing fascinating insights into the world of cold-blooded creatures of all types.

Talking tortoises

When it comes to choosing a pet reptile, a tortoise is the obvious starting point for many people. These particular creatures have been popular pets in Britain for over 400 years now. Unfortunately though, in the past, their care needs were far less well understood than they are today, and there are still a number of outdated beliefs surrounding the care of this group of reptiles.

Come along and see how to create the best possible environment for these amazing and frequently misunderstood creatures, as part of the special Tortoise Feature, which has been designed in association with the British Chelonia Group. You can get the latest information, and learn what tortoises need for a (very) long and healthy life.

Invertebrates as well

There is also a garden wildlife section, with interactive displays that mix fun with learning. You can also help to create an old-fashioned bee skep and discover how to make candles from beeswax.

If this sparks your interest, you certainly won't want to miss Minibeast Corner. Presented by the Natural World Experience, this feature will showcase exotic insects and arachnids from around the world in all their glory. ✣

Advanced ticket prices for either day

- **Adult Ticket** (18 - 60 yrs) £14
- **Senior Ticket** (60 +) £9
- **Child Ticket** (8 - 17) £9
- **Under 7s** FREE
- **Family Ticket** (2 adult + 2 child) £36.80
- **Show Guide** £1

You can book tickets online at http://www.thepetshow.co.uk/tickets/ or call the ticket hotline: 0844 844 0444. Advanced Ticket Prices are subject to a booking fee. Telephone calls cost 10p per minute plus standard network charges

On the door prices for either day

- **Adult Ticket** (18 - 60 yrs) £16.80
- **Senior Ticket** (60 +) £10.80
- **Child Ticket** (8 - 17) £10.80
- **Under 7s** FREE
- **Family Ticket** (2 adult + 2 child) £44
- **Show Guide** £1

Accommodation

There is free car parking, and, if you want to make a weekend of it, you can book a room or a camping pitch on site in advance with Stoneleigh Park Lodge. Details are available online at http://www.stoneleighparklodge.com/

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Under 7s:	FREE
Family ticket (2 adult + 2 child):	£44
Show Guide:	£1

Book tickets online: www.thepetshow.co.uk

REPTILE FOCUS

Common snapping turtle *(Chelydra serpentina)*

The direct ancestors of this large freshwater species can be traced back over 200 million years, which helps to account for their decidedly prehistoric appearance. They represent a group that saw the dinosaurs come and go, and are still alive today.

The common snapping turtle has a wide distribution in its North American homeland, stretching from south-eastern parts of Canada right down to Florida. The population of snapping turtles that occurs further south, in parts of central and north-western South America, has now been subdivided into two separate species.

Although well-equipped to hunt with their powerful jaws, these turtles will often scavenge for food. There is a story of one being trained successfully to help law enforcement officers track down the bodies of people who had drowned in waterways, operating off a stout line, using its scenting skills for this grisly task.

These turtles have a remarkable reach with their highly flexible neck, a fact reflected in their scientific name '*serpentina*', meaning 'snake-like'. They can bend their neck right around the sides of their shell, which can make handling large individuals quite difficult. The safest way for both turtle and handler is to lift the reptile by holding the carapace behind the back legs.

In the case of large adults, the length of their carapace (upper shell) can reach nearly 50cm (20in), and they can weigh around 16kg (35lb). Snapping turtles have a reputation for being aggressive, and aside from their jaws, their claws can potentially inflict painful injuries as well. They usually give a warning before biting though, by hissing first.

Common snapping turtles can be found in ponds and slow-flowing stretches of water, as reflected by the algae present on the face of this individual. They may sometimes even be encountered in brackish water too.

These turtles have been hunted for many years for food, but adults otherwise face few threats in the wild once they are fully grown. Common snapping turtles are unlikely to start breeding until they are maybe 15 years or older, and they have a potential life expectancy of over a century.

QUESTIONS & ANSWERS

DO YOU NEED A HELPING HAND OR ADVICE?

Email your queries to prk.ed@kelsey.co.uk or write to the address on page 66. A selection of submitted questions will appear here every month, and a prize of Vetark products will be awarded to the writer of the Star Question. Regrettably, replies can only be given through this column, and if you are worried about the health of your animal, seek veterinary advice without delay.

I am about to receive a pair of mountain horned dragons. Are there any special quarantine procedures that would help them to acclimate? How can I make sure that they settle as quickly as possible from the outset?

Well-planted surroundings where cover is easily accessible will lower a newly-acquired reptile's stress level.

Settling in new arrivals

These are vital questions that we should all be asking ourselves every time that we welcome new animals into our collections, regardless of the species concerned or its origins. I have learnt some small tricks over the years that will help an animal settle in quickly, and reduce the risk of disease and stress-related death. I must say, however, that as technology improves, the whole process becomes easier.

I will make one thing very clear; these principles all apply to all animals. Not just those that have arrived directly from the country of origin. We should acclimatise captive bred and captive farmed stock with equal care.

Worries over stress

We must place high importance on the incidence and actions of stress upon an animal. This condition can be caused by capture, transport of both long or short duration, confinement, new enclosures, new diets, lack of hydration and, of course, by other individuals sharing the enclosure.

Stress is to be expected to some degree, but it is how we as the keeper and as such, the provider for that animal, and the way that the animal handle this stress that is important. Stress in itself can sometimes be fatal. You can often hear stories of animals that simply expire for no obvious reason soon after being moved, but it is the long-term effect of stress upon the body for the majority of animals that is of most concern and is most common.

Make sure the enclosure is designed so that arboreal lizards, for example, can climb around their quarters.

Stress not only causes spikes in the levels of the stress hormone cortisol, which can be measured, but it has other far-reaching biological effects also. Stress not only places a heavy load upon the brain and general wellbeing of a reptile but it also decreases the potency of the animal's immune system and gut flora.

This then can lead to underlying infections or parasitic build-ups which can become very problematic, often in a very short space of time indeed. It can lead to a lack of colour, high levels of aggression or timidity, and, commonly, a frustrating refusal to feed.

A healthy balance

If we can negate the incidence of prolonged stress, then we will reduce the possibility of infection and illness. It does not stop there either, as we need to look at the whole system that we are providing for the individual(s) of that species. You must make sure that all of the electronics, for example, are functioning properly before the animal arrives in your home and of course, we should also factor in the importance of 'wild re-creation' and make changes to provide for this.

Wild re-creation is the way forward for almost all species. It is a very straightforward principle. If we provide a species in an enclosure with the parameters that it has evolved to experience and adapt to in the wild, covering such factors as heat, light, UV indexes, air flow, humidity/hydration and diet, we then by definition provide for that species' specific basic needs.

With any new acquisition, you should collect faecal samples for testing as soon as possible, and treat any potentially harmful parasites on the basis of specialist veterinary advice. I myself choose to use a herbal powder called Verm-X, which may boost the beneficial microbes in the gut, improving intestinal health as a result.

When chemical deworming is required, this type of medication can interfere with the gut flora. The trouble is that chemical wormers tend to strip out the useful gut flora and this In turn can reduce an animal's ability to digest its food, quite apart from dealing with stress. If in any doubt, ask

Spraying the plants will provide regular opportunities for rehydration.

a vet for advice.

With a new arrival, allow it to settle in quietly. Assuming animals are basically healthy, they generally seem to settle down and show signs of improving colouration and health very quickly, even in the case of imported individuals.

Making preparations

Go back beyond this though and right at the outset, read up properly about the species that you wish to keep. Make sure that you research the wild environment and terrain and behaviour of that species. You can then use this vital information to re-create a microcosm of the wild habitat of that particular species.

As an example, if you have acquired a wild-collected mountain horned dragon, you should seek to provide it with the average temperature that is local to its home range, and include a UVB system that projects the correct basking index of 3-5 at the basking point. You also need to make sure that you have an enclosure that is designed to be tall enough to allow these lizards to climb, and is sufficiently well decorated to allow them to hide. It needs to be planned so that it can be sprayed down safely twice a day to allow the lizards to drink.

Set the enclosure up at least a week before the animal arrives, to allow the lamps and heating systems to burn in and reach full power. This also gives the opportunity to iron out any frustrating electrical faults beforehand.

Always choose your own stock as well, even if this means travelling some distance for this purpose. You want to see clear eyes, with no stuck and partly shed skin on the body (typically appearing as white patches) here. The feet and nails need to be clean, as, more importantly, should the vent area.

There must be no discharge from the mouth or nose, and a generally lively personality tends to be a good sign. Watch out for orange patches on the underside of the belly that can represent a sign of bacterial infection. When you have made your selection, make sure that the animal is packed well and that you go directly home.

Here you will need to double check the vivarium parameters, and put in the standing water in a suitable, safe container. Spray down the interior for those species such as chameleons that drink from droplets and then all should be ready to put the animal(s) in place.

Arrival at home

Generally, it is better to not handle the animal, but allow it to emerge from its tub or box directly into its enclosure. When the animal is safely within, give it a light spray, turn the lights off while leaving the heating on, cover the viv with a sheet or towel and leave it alone until the next day. As always take care not to spray any of the electrics, which would be likely to have very serious consequences, and ensure there is no fire risk when you cover the vivarium.

On day two, put the lamps back on, and collect any faecal matter that you can see for screening. Check the water, spray down safely as required and quickly introduce a very small amount of supplemented live food for insect eaters or plant matter for vegetarians.

Remember that snakes should be allowed a few days to settle before being offered food. Never over feed or leave excess live foods in the vivarium – this could actively harm the occupant. Visually check the animal, cover and leave alone for the rest of the day.

Never rush!

I tend to have very limited interaction with an animal for the first week. Those species such as the common agama (*Agama agama*), not to mention the Asiatic forest lizards (*Calotes* species) that are especially prone to stress-related issues, can be left with their quarters safely covered for a week or so. If you can do this, it will greatly increase the likelihood of them settling in successfully.

After a few days you can remove the vivarium cover and start to interact with your pet, carrying on with routine tasks, but aiming as always to keep stress levels as low as possible. It is much better to allow an animal to settle down and come to you in its own time.

The parameters that you have built into your vivarium design will provide the animal with its own specific, core needs and it should settle down well on its own. Above all perhaps, hydration is key. We simply must get water into our pets in the right way and in sufficient volume.

I tend to over-spray on the first day. Many will drink for long periods at this stage, especially those that have travelled long distances and may not have had the opportunity to do so for some time. Once rehydrated as necessary, the vital organs will function properly and the animal's biology will equip it to adapt and thrive in its new home.

We all know how exciting it is to get a new pet, and just how strong the urge to interact with it can be, but for many species of lizard especially, it is simply worth investing a week or so into the acclimatisation process. You should then be able to enjoy its company without serious problems developing for the rest of its natural lifespan. Always remembering that once lizards or other reptiles are established in their quarters, they rarely fall ill.

John Courteney-Smith,
Reptile Products Manager, Arcadia.

When you have a pair or group of lizards housed together, watch for any signs of bullying and be prepared to separate them if necessary.

All photos courtesy of the author.

Diary of a mantella man

Adventures in Madagascar

Part Three

Joshua Ralph sends another report back from the field in central-eastern Madagascar, detailing more of his findings and research within the Andasibe area. In this issue, he details the hard work that went into finding some amazing species, including *Uroplatus* geckos and many species of amphibian.

After a month of being here, and three weeks after my last real adventure out into the rainforests on the eastern coast of Madagascar, I decided that I ought to head off into the forests and start trying to find the many different species that I could locate, whether during the day or night.

However, my mission for the morning hike was to find something in particular, a species of gecko that truly is both remarkable and fascinating, in the guise of the mossy leaf-tailed gecko (*Uroplatus sikorae*). This is a species that is rarely seen in collections, and is certainly not easy to spot in the wild, thanks to its truly remarkable camouflage.

VOI MMA Community Park, Andasibe. A trek into the local community forest.

As always, I woke up ready for the day ahead with excitement, but I was more fatigued than when I had been on my earlier hikes into the rainforest. I had picked up some kind of illness that was affecting me so badly that it was under consideration to send me to the nearest hospital in Madagascar's capital, Antananarivo for treatment.

I decided to continue though, and worked around my illness rather than taking this option which would have been rather like giving up in my eyes. At this point in my adventure though, it looked like I was getting better anyway.

➤ **Main Image: Mossy leaf tailed geckos are very variable in appearance.**

All photos by the author except (Both P38 , Top & Bottom: P39)

My stomach pains didn't last as long and I could finally leave my bed without collapsing, as had been the case previously.

Community involvement

It struck me that it was time to take a visit to the newest reserve, VOI MMA Community Park. This was slightly different to the other reserves and national parks, as instead of the guides organising the hikes and tours but only getting a portion of the money, they received all of the profit. In return, they maintain the area themselves, looking

A beautiful morning in Andasibe, where Josh was based.

after the forest and protecting it.

I set off, exhilarated to be going out into the reserve which lay just outside the town, and determined to find this lizard which in my mind had been built up to be some kind of mythical beast, based on from what the local guides and townsfolk had been telling me.

Once I was actually in the park, I met up with a fantastic guide called Pierre, nicknamed 'Paa' by his friends.

After we discussed the plan and decided which route we would take through the forest and what we were after, I pretty much decided there and then that I would go all out and go on a night hike as well!

I paid my guide fee and immediately we headed off into the forest, and at this early stage I already appeared like a demented spotter, scouting through the undergrowth and looking at every small and tiny movement as I walked along, but in vain.

A special tree

Eventually, after hiking for half an hour, we reached a meandering section of the Analamazaotra, a river that runs through the Andasibe-Mantadia National Park and the town itself. Across on the other side of the water, I noticed brightly coloured banners fixed up and around this single tree, which was noticeably larger than the others.

It looked important, so I asked Paa about it. He replied that it was a sacred and holy tree. Superstition surrounded it and I was told that people made ritual sacrifices and prayed to it for anything they desired, such as conceiving a child or asking for good luck.

Strangely, however, what grabbed my attention was that no-one actually knew the particular species of tree, and apparently, it was not known to grow anywhere else. Yet it was highly protected, as the result of local folklore.

It turned out that people tried to cut it down in the past, to turn it into lumber but before they had the chance, they mysteriously died… More than likely this was a tale embellished for tourists with an entirely logical explanation, but there was no doubting that the local people felt this tree had mystical powers.

A new find

We continued on our journey along the winding pathway up the hillside, but much to my disappointment, we did not come across a single species of animal. We had heard calls but actually seeing any sign of wildlife was a very different story.

After walking for two hours, I was feeling pretty deflated, and I was prepared to wait until the evening - that was until we reached the top of the hill and the landscape there was completely different. There was sandy and loose soil, with a strange type of moss covering shaded patches of the ground.

Finally, in a pandanus (or vakona) tree that measured approximately 2.4m (8ft) in height, I saw something jump amongst the leaves. It turned out to be a species of *Guibemantis* frog, but it was nothing like any that I or Paa had seen before. This was new… again!!

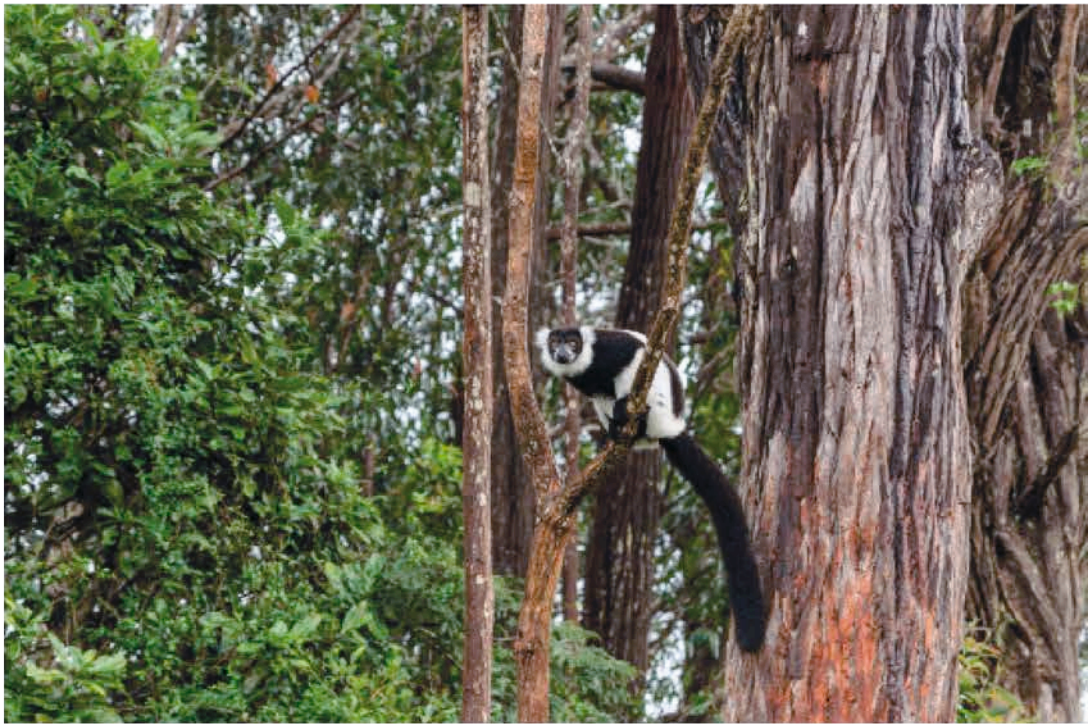
It was another species that has potentially not been described before. So until someone researches this species and describes it formally in a scientific paper, it has to be called *Guibemantis sp. nov.* (with '*sp. nov.*' meaning 'new species').

There are many species yet to been described from Madagascar, just like this *Guibemantis sp. nov.* specimen, and others yet to be discovered.

Spotting a gecko

I was happier now, and it built my confidence up again. Barely five minutes later, I then encountered what I had so desperately wanted to see - one of my 'bucket-list' species! I won't glamourise the sighting though, and make it sound like I found the species myself. In fact, it took me ages even to even spot it…

I literally had Paa jumping and down saying "I did it, I did it! I found a uroplatus!" which I was desperate to see, sharing my guide's enthusiasm. Once I finally spotted it, I couldn't believe my eyes. It was a perfect juvenile male specimen of the mossy leaf-tailed gecko (*Uroplatus sikorae*), hidden so well you wouldn't have thought there was anything there. I stood there shocked, and studied this animal in awe at this amazing example of superb camouflage. ➤



A view of the Andasibe forest, with a black and white ruffed lemur in view.

The lowland streaked tenrec (*Hemicentetes semispinosus*) resembles our European hedgehog species, but is not closely-related.

Unfortunately though, time was pressing and we had to leave the forest, but I was ready for that evening, to continue our journey into the Mitsinjo Forest.

Mitsinjo Forest & Parc des Orchidee, Andasibe. My first night hike.

Later that day, I rendezvoused with Paa again, but this time, we were equipped for an entirely different kind of hike, with torches and head lamps and also, first aid kits for the only reason that this time, we were heading out into the middle of the rainforest at night. Smiling away as usual in his friendly manner, Paa asked what I wanted to see.

I gave him my list of 'must-see' species, including several amphibians and any species of tenrec. With that, we set out without further delay and started scanning our surroundings whilst trying not to fall down the steep stone steps that lay before us.

A painful encounter

I don't know what it was, but my senses seemed to be greatly enhanced and I could hear everything. It was almost as though the darkness impairing my sight made me more alert. This ability certainly came in handy as moments later I heard rustling and, without a second thought, I leapt to catch the culprit in the leaf litter.

The quills – which are modified hairs – allow tenrecs to communicate with each other over great distances, but they can be used for defensive purposes too.

➤ *Uroplatus* species are incredibly hard to spot in the wild, blending in so well against the background.

I found myself grabbing a most gorgeous male specimen of lowland streaked tenrec (*Hemicentetes semispinosus*). What made the experience even more amazing was that this was literally five minutes after telling Paa that these insectivores were on my want to see list! What makes them so interesting is not only their huge resemblance to our European hedgehogs, but also their special method of communication.

On their rear, they have a small collection of quills spaced closely together, which allows them to perform what is known as stridulation. They literally rub these quills together producing a sound that is audible to their fellow tenrecs over a considerable distance.

Anyway, without wanting to causes further stress, I let the little guy go. This then allowed me to take out more than 26 of the quills that he had left in my thumbs and fingers!

Snakes in short supply!

Shortly afterwards, we reached a bridge crossing a small stream, and we observed a small and brightly coloured arachnid. Paa didn't pay attention to what might lie behind him, but then I reached out with my right hand and pulled him back gently, pointing towards a snake located on the ground. It was a Madagascan ground boa (*Sanzinia madagascariensis*).

This really was only the second species of snake that I had seen so far on my trip, and it was impressive, even if it was only 0.9m (3ft) in length from snout to vent. We both laughed about the encounter and Pierre thanked me, not that it would have caused him any injury, but because he didn't want to hurt the animal.

We went cautiously around the snake, so as not to disturb it too much but its

➤ The mossy leaf-tailed gecko (*Uroplatus sikorae*) is popular with gecko enthusiasts, and is a master of disguise.

There are many species of snake to be found across the island, such as this Madagascan ground boa (*Sanzinia madagascariensis*) of the Andasibe locality type.

head was raised already and it was prepared to take defensive action if needed. After we reached the other side of the bridge, we were finally in the forest and already, I was satisfied with what we had seen - everything else would be an added bonus tonight!

Out in the darkness

It was an odd feeling though, being in the forest at this time of night, walking in pitch-black surroundings. Before I knew it, I was scanning in front of me again, copying my guide's method of searching, and moving slowly.

Before long, there was another animal I hadn't seen, in the guise of the plumpest little chameleon ever. This was a heavily gravid female perinet striped chameleon (*Calumma gastrotaenia*). She was truly gorgeous and sleeping when we discovered her, after which she headed off for a new retreat where she could rest undisturbed.

Her neighbours however, refused to wake and this gave me opportunity to photograph them together. They were a sexed pair of pygmy leaf chameleons (*Brookesia superciliaris*).

A nocturnal chorus

We returned to the path and continued, down to a stream, which was a place I knew would provide more creatures of interest, particularly to an amphibian enthusiast like myself. In fact, even before we reached the water, the area was alive with the chorus of the frogs living there.

Following the sound, it caused me to jump over the water unexpectedly, showing elegance (only because I never fell in!) and right there in front of me was a sub-adult male Madagascan brown tree frog (*Boophis madagascariensis*) calling away. I then had an ongoing battle, attempting to photograph his display. Every single time I clicked the trigger, he called directly afterwards, as if he knew what I was doing and I missed the moment!

But he was not alone carrying out this nightly performance. Just 0.6m (2ft) away was something much more impressive in colouration, in the form of a fully adult male Boehme's tree frog (*Boophis boehmei*). It had the most attractive eyes that I had ever seen in any animal. They were a vivid, bright red with the outer ring being sky blue in colouring, combing to create a truly entrancing effect.

➤ The perinet striped chameleon (*Calumma gastrotaenia*) is one of the smallest species of chameleon in the Andasibe area, and also one of the most striking.

Drawn to the light

I loved using a head torch as I continued walking through the pitch-black landscape. It was certainly much easier than carrying a cumbersome hand torch, as it left me with both hands free. This meant that I could move around more confidently, but the head torch could generate its own problems.

Every so often, my private space would be violated by the sudden and startling appearance of a moth or giant butterfly that was attracted to the light. In some cases, I ended up recoiling and having to spit out the arthropod that had collided with me.

Although quite plain to look at in comparison with some species, the pygmy leaf chameleon (*Brookesia superciliaris*) has a remarkable appearance.

➤ The brown tree frog (*Boophis madagascariensis*) has quite an impressive appearance. Males can be easily identified by the spurs present on their hind limbs. This species is generally common.

A rare sighting

But there are of course much bigger creatures that can be encountered on Madagascar. As we ascended the steep hill, Paa told me to stop and quickly grabbed me so I spun round. I had no idea what was happening until I saw it… ➤

Boehme's tree frog (*Boophis boehmei*) has a very unusual appearance.

a species of nocturnal lemur no more than 3m (10ft) away in the lower branches of a tree.

However, this was not any ordinary lemur, and, as I subsequently discovered from people at the facility later, it is rarely sighted. The last specimen of the elusive hairy-eared dwarf lemur (*Allocebus trichotis*) had been spotted almost more than a year previously.

The sole member of its genus, this dainty and delicate looking mammal will have a specific tree that it favours. In fact, as Paa told me, I had woken it up, which explained its rather dazed demeanour.

A chameleon resembling an elephant

Soon enough though it was gone, which gave us our hint that probably we should move on ourselves too. We reached the Parc a Orchidees (Orchid Park) at this point which meant we were nearing the end of the hike. Yet as we stepped under a low-bearing branch, I looked up and saw yet another species of chameleon.

This was a male short-horned chameleon (*Calumma brevicorne*), which is also known as the elephant-eared chameleon. The species has a head crest with flaps that can be used in territorial disputes or to deter any other threat. These flaps can be pushed forward, resembling the ears of a angry elephant as a result, accounting for its unusual name.

There are some beautiful moth and butterfly species to be found on the island.

After having woken up a now angry lizard, I spotted something nearby that I had to look at twice to try and make sense of what I was seeing. It turned out to be a pair of the most unusual and cleverly camouflaged moths. I have no idea what they were but they mimicked perfectly dead or dying leaves upon a branch, the only give away was eyes that you really had to concentrate on seeing…

A final discovery

Eventually, we left the forest and were finally upon the road, but there was one last surprise on the pathway, in the form of another incredibly species of dwarf lemur! It really was my night for oddities and rare sightings.

This was a species that had only been discovered in 2005. It was Goodman's mouse lemur (*Microcebus lehilahytsara*), which is one of Madagascar smallest lemurs. I couldn't believe how close I was able to get to it; I was literally within touching distance but, of course, I didn't try to do so.

We moved on before a noisy group of German tourists came close enough to realise what we had found, so we could leave the lemur continuing to feed on berries. I walked on back to my house, eagerly waiting the opportunity to return again, after thanking one of Andasibe's finest guides…

Mitsinjo Forest & Parc des Orchidee, Andasibe – my second night hike.

After a few days, I decided it was time to return, and so I organised a private hike with Eudipsie, my friend and fellow technician at the facility. He also had a reputation for being an excellent guide, albeit on a part-time basis.

So we met up at a similar time to when I had headed off with Pierre and we set out together. I felt more relaxed this time, knowing what it was like moving through the forest in the darkness. Not long after we began our descent down those same

➤ The hairy-eared dwarf lemur (*Allocebus trichotis*) is a rare sight in the forests, sometimes not being recorded for years.

Chameleons like this short-horned chameleon (*Calumma brevicorne*) are incredibly easy to spot at night.

Leaf-mimicking butterflies always appear to remain in pairs, with one more lightly coloured than the other.

steps where I had seen the tenrec previously, it began to rain quite lightly.

Suddenly, Eudipsie wandered off the path towards a giant pandanus tree. With his hand torch, he revealed not one but three highly variable *Guibemantis liber* specimens, jumping around wildly, although I was able to get a photograph of the encounter. It made me realise that my photographic skills had definitely evolved since I had first arrived, as these frogs were far from co-operative subjects.

Goodman's mouse lemur (*Microcebus lehilahytsara*) was discovered in 2005 and named after the primatologist Steven M. Goodman.

As in the case of many frogs, members of the same species can be highly variable in appearance, as with this *Guibemantis liber* specimen.

A hungry companion

We then moved on and entered the thicker forest. I then became aware of a slight pain on my arm underneath my long sleeve. It was a mere pinch at most but it was an odd sensation, so I instinctively pulled my drenched sleeve up only to find a leech.

It was beginning to numb my arm and inject its anti-coagulant saliva so it that it could feed on my blood. However, unlike the vast majority of people in this situation, I was fascinated and stood there watching the process until enough was enough! I brought the leech's feast to a conclusion by a sharp flick that dislodged it on to the ground.

A tiny chameleon

Eudipsie, who hadn't noticed my dawdling caused by the leech, then called me over to look at what he had found. It was the most delicate baby chameleon that measured no more than 2cm (0.78in) overall. He had come across a big-nosed chameleon (*Calumma nasutum*), which is one of the smallest to be found in the Andasibe area of Madagascar.

Adult specimens of this species only grow to a grand size of 10cm (4in). How he saw it was beyond me, it was clearly a skill that I had yet to acquire, so it seemed! However, I was certainly already developing a keen sense for finding and noticing sudden movements and being able to identify them as amphibians.

Up above

This enabled me to spot a female Madagascan black-sided frog (*Mantidactylus melanopleura*) on a branch. She seemed content with being in the open, and then froze, not moving a muscle even with my camera lens being only inches away.

It was overwhelming seeing the biodiversity in the area at first hand.

▲ The big-nosed chameleon (*Calumma nasutum*) possesses an unusual and prominent nose, which is more pronounced in males, as is generally the case with the majority of chameleon species.

▼ A black-sided Madagascan frog (*Mantidactylus menlanopleura*) completely unbothered by human attention.

There were animals of all types around us. Yet at this point, we were barely a quarter of the way through this hike, which Eudipsie suggested that we should extent by an hour or two.

Although entranced by combing the forest floor, I soon realised that there was a whole vibrant community of creatures above us as well, concealed in the canopy of the rainforest.

An unusual sound echoing across the forest drew my attention here. It was a sound that I had heard before, and ➤

The mossy tree frog (*Spinomantis aglavei*) reflects the phenomenon of convergent evolution, being similar in appearance to an unrelated species occurring in Asia.

Some frogs can appear like glass, being almost transparent just like this *Boophis tasymena*.

recognised as being the call of a male mossy tree frog (*Spinomantis aglavei*). These amphibians were all above us and it wasn't long before we sighted one close enough to see it properly, up close.

These particular amphibians are stunning metallic green, shining with iridescence and they looked very similar to the better-known Vietnamese species described scientifically as *Theloderma corticale*, apart from possessing a much longer snout.

▲ The central bright-eyed frog (Boophis rappiodes) has an impressive and highly attractive appearance.

Animals that are unafraid

The rest of the forest, however, was quieter, and eventually, we worked our way to the Orchid Park again, making a great effort to see more wildlife in the remaining time we had left. As always appeared to be the case, the park did not let us down, although the most unusual sighting was actually of another rare nocturnal lemur.

We spotted it roaming around the low-bearing branches of a fruit tree. It was an eastern fat-tailed lemur (*Cheirogaleus crossleyi*), named after the rounded shape of its tail. This was clearly an attribute that helps it to jump and climb between trees, with balance being crucial to guard against falls.

For some reason, we were able to get yet again within a mere 1.2m (4ft) of this lemur. Then it dawned on me that all these rainforest animals do not apparently regard humans as a threat, in spite of all the environmental damage that we have caused on the island.

A gold speckled tree frog (*Boophis idae*).

Boophis bottae exhibits unusual markings, some of which are not apparent in any related species.

Many species are no larger than a few millimetres overall, after morphing from tadpoles, as shown by this Malagasy reed frog (*Heterixalus punctatus*).

Wet weather brings a bonus

The rain began to fall harder at this stage. I was already drenched and was starting to feel tired. However, there was still plenty more to see, because as the rain got heavier, so more amphibians were drawn out from their hiding places.

Within quick succession, I had frogs appearing out of nowhere around my feet. The first to present itself was a gold speckled tree frog (*Boophis idae*), so-called thanks to the golden markings all over its body. This gave it the appearance of being covered in metallic flakes.

At the same time, another frog caught my eye. It was tiny, and clearly had only just metamorphosed. This was a *Heterixalus punctatus* out enjoying the downpour, perched on a miniscule twig. It was unbelievable. I honestly hadn't anticipated such a gathering of frogs.

Soon though, more species of *Boophis* were appearing in the bushes, clambering over the leaves. There were three species that I spotted, all of which have no common names. They were *Boophis tasymena*, *Boophis bottae* and *Boophis rappiodes* with each displaying their own unique colouration and markings.

I could have stayed there much longer, but soaked through and feeling decidedly fatigued by now, it was time to head back, after a night that I shall never forget. ✣

A giant survivor

The Chinese giant salamander is the world's largest amphibian alive today. The species is so rare that you've probably never seen one, but now there is an opportunity for you to view this truly impressive animal, as Susie Kearley reveals.

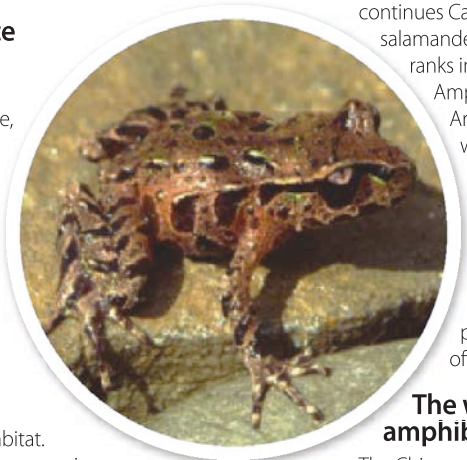
Carly Waterman is currently working on a conservation project to protect the Chinese giant salamander and its habitats, on behalf of the Zoological Society of London (ZSL), which encompasses both ZSL London Zoo and ZSL Whipsnade Zoo. As part of this project, there is a Chinese salamander – the only one of its kind in the UK – currently to be seen on public display at ZSL London Zoo.

The EDGE of Existence programme

In 2007, ZSL launched their EDGE of Existence programme, a project managed by Carly, who explains how it works, "EDGE stands for Evolutionarily Distinct and Globally Endangered. We work with conservation groups around the world, focusing on securing the survival of genetically unique endangered species by supporting, expanding, and protecting their remaining habitat.

"The EDGE programme scores species on two key elements. Firstly, they are prioritised based on how threatened the species is in the wild. That's the 'Globally Endangered' aspect of EDGE.

"Secondly, they are prioritised based on how unique their genetic material is - this means that those species having few, if any, relatives in the animal kingdom, score highly on this element. That's the 'Evolutionarily Distinct' aspect of EDGE. The two scores are then combined to produce an overall EDGE score for each species," says Carly.



➤ **Archey's frog scores as the most endangered amphibian in the world, based on EDGE's criteria.** Photo courtesy David M. Green, CC Attribution ShareAlike 2.5.

"We look at the top 100 high-scoring species and aim to have conservation schemes in place for those animals. Some EDGE species already attract conservation attention, but many others are overlooked. That's when EDGE steps in.

"We launched EDGE Amphibians in 2008 and found that 85% of the top 100 amphibians in need of help were receiving little or no conservation attention," continues Carly. "The Chinese giant salamander is one of those species. It ranks in second place on the EDGE Amphibians list, just behind Archey's frog from New Zealand, which is one of the world's most primitive species of frog.

"The EDGE programme is expanding to protect endangered reptiles as well. It is taking time to develop the reptile list though, and at present, we're quite a long way off completing this task."

➤ **Carly Waterman is EDGE's programme manager.** Photo © ZSL London.

The world's largest amphibian

The Chinese giant salamander (*Andrias davidianus*) is the largest amphibian alive in the world today, measuring over 1m (3ft) in length. "Ours displays the typical bulging muscles and a giant 'grin' across his face!" says Carly, and according to the keepers, ZSL London Zoo's newest arrival is already making a big impression. People find this salamander fascinating!

Staff have named him 'Professor Wu', after one of the project's partners in China. He's the face of the ZSL's new conservation project, which was established to help ➤

Aims and objectives

ZSL LET'S WORK FOR WILDLIFE

ZSL's stated mission is "To promote and achieve the worldwide conservation of animals and their habitats... realised through our ground-breaking science, our active conservation projects in more than 50 countries and our two zoos, ZSL London Zoo and ZSL Whipsnade Zoo".

EDGE investigations in China are helping to provide more knowledge about the lifestyles of these giant amphibians. Photo © ZSL London.

DID YOU KNOW?

Amphibians across the world are declining in numbers and in China, where 75% of the native creatures are eaten, 84% of amphibian species are being adversely affected by poaching. This appears to be largely unaffected by the conservation efforts put in place to try to protect some of them.

prevent these unique giants from becoming extinct in the wild. He's 19 years of age, and came from Rotterdam Zoo to be the ambassador for the project.

Giant salamanders are often referred to as 'living fossils', having existed for some 179 million years, and visitors to the zoo can see Professor Wu in the 'Land of the Giants' exhibit, where he swims among rocks and caverns. He likes to hide away and seeks to ambush his food.

These salamanders are classified as critically endangered by the International Union for Conservation of Nature, and are facing the threat of extinction as a result of hunting for human consumption, as well as habitat loss and destruction in their native China.

Ben Tapley, leader of ZSL London Zoo's reptile and amphibian team, says: "While Chinese giant salamanders may not be everyone's idea of 'beautiful', we think Professor Wu is more than capable of winning over our visitors.

"He's an impressive size, measuring 1.3m (4.25ft) from snout to tail, and on top of that, he has a feisty personality – it took a team of four of us to move him to his new custom-built home!

"As well as being an exciting new arrival here at the zoo, this giant salamander is a great representative for our ground-breaking conservation project in China, where we really want to turn the fate of this critically endangered and evolutionary distinct species around."

The giant salamander in China

The Chinese giant salamander can theoretically grow to a maximum length approaching 1.8m (6ft), although it's rare that they ever reach this size – especially today. They may continue growing through their lives, which can easily extend over half a century or even longer.

These salamanders inhabit the rocky mountainous areas of China and Taiwan (where they may have been introduced), being found there in both fast flowing rivers and clean lakes. Unfortunately, the salamander's meat is a traditional culinary delicacy in China and parts of the animal are used in traditional Chinese medicine as well, which makes them a much sought-after target for poachers. In the wild, their numbers have declined by about 80% since the 1950s.

The salamander varies from pale orange to dark brown in colour, and has a large body with small, round eyes, a wide mouth, and blotched, wrinkly skin. They are capable of making strange noises that can resemble a bark, whine, hissing or crying sound.

Their diet consists of invertebrates, fish, crabs, and other amphibians like frogs, and they use their senses of smell and touch to find their way around, since their eyesight is very poor. These salamanders rely on sensory nodes on their skin, which enable them to sense vibrations - that's how they find their prey. They hunt by expanding the size of their throat and then sucking water and prey into their mouth. When threatened, they produce a white peppery fluid to warn off predators.

▲ **Typical Chinese giant salamander habitat in their homeland.**

The females lay 400 to 500 eggs in a burrow in slow-flowing water, and the male guards the clutch until the young hatch after 50 to 60 days. Breeding typically occurs between July and September.

The Chinese giant salamander is totally aquatic and it lives, breeds, and lays its eggs under water. It tends to prefer dark rocky pools and fast-flowing shallow rivers in forested regions at high altitude.

Despite determined efforts over three decades to conserve the species, which have included the creation of nature reserves and efforts to assist these salamanders when their habitat is disturbed, their decline has continued. It has been exacerbated in recent years by the epizootic ranavirus infection, the main symptom of which is severe haemorrhaging. The disease was given the name of Chinese giant salamander iridovirus when first identified in this species five years ago.

◀ **Chinese giant salamanders are potentially very long-lived. This individual, photographed at the Staatliches Museum für Naturkunde Karlsruhe, Germany is 30 years of age.** Photo courtesy H. Zell.

Main threats

The biggest threat to the future existence of Chinese giant salamanders is illegal poaching. Unfortunately, these giants are easy to catch and they fetch a high price. Poachers can sell them for $100-150 US dollars (£65-£98) per kilo (2.2lb), with a typical adult salamander weighing some 25-30kg (55-66lb). Conversely, the fine for poaching these animals in China is just 50 yuan (£5.15), which provides no real deterrent.

Salamander farms have now been set up

➤ A cavernous mouth and very small eyes are features of the Chinese giant salamander.
Photo © ZSL London.

to meet demand and reduce the impact on the wild population. Unfortunately, they do not appear to be improving the conservation status of these amphibians by stemming illegal trade – perhaps because they can also provide a cover for illicit sales?

Even nature reserves, set up by people trying to conserve the species in the wild, are proving ineffectual, being targeted by poachers. The losses are so catastrophic that some believe it is unlikely that the original numbers of these giant salamanders will ever be restored, even if effective habitat protection and controls to prevent pollution are put in place.

The construction of dams, water pollution from mines, pesticide use, and growing industrialisation have all contributed to the destruction of the habitat of these giant amphibians. When the water is polluted, or covered with algae, they are unable to obtain sufficient oxygen from the water through their gills.

Furthermore, the algae also make the water heat up, by trapping warmth, which is dangerous for the survival of this cool water species. Not only does heat affect their health directly, but these amphibians are unable to breed if the water temperature is too hot.

Chytridiomycosis is another threat. It is a deadly fungal infection that occurs most often in cooler habitats, and has already contributed to the extinction of a number of amphibian species globally.

Field studies

ZSL is leading a conservation project in China, assisted by local EDGE Fellows - people who have been trained to develop the skills needed to carry out specific research. The project aims to gather the knowledge needed for future salamander conservation, by undertaking the largest wildlife survey in China's history.

This entails surveying river systems for wild salamanders, placing humane traps and searching the rivers at night, to look for salamanders in a particular area. When team members catch a salamander, they take swabs from inside its mouth, which enables scientists to check for disease and better understand the genetics of this species.

The numbers found in each area are recorded, and the salamanders are then released back into the river. The researchers are very careful not to harm the creatures while undertaking survey work.

➤ Education can perhaps help to play a part in the survival of the Chinese giant salamander. This individual was photographed in China's Shanghai Aquarium.
Photo courtesy J. Patrick Fischer.

Global support

Back at ZSL London Zoo, Carly explains: "I've been working on the ZSL EDGE programme for almost 10 years, following a six month stint as a volunteer. I obtained a degree in animal behaviour, went to Borneo to study wild orang-utans, and became interested in conservation. It's progressed from there!

"It's quite hard to obtain a job in conservation so I applied for a six month internship at ZSL – volunteering is a great way to get into this area. I was lucky that my internship led to a job. The EDGE programme operates with a small team of just three full-time and two part-time people. But my work location - at ZSL - enables me to tap into a huge wealth of knowledge and expertise from my colleagues who work in the zoos, the conservation department and the Institute of Zoology.

"My role is to oversee all the research and conservation work. I support the development of additional EDGE lists. We have priority lists for mammals, amphibians, birds and reef-building corals at the moment and are currently working on an EDGE sharks list.

"We are currently supporting 25 different projects around the world, with most being led by in-country conservationists. We empower local conservationists to develop their own projects through our Fellowship programme. We help them get the projects up and running from an early stage, and provide mentoring, technical advice, and financial support.

"EDGE Fellows - our overseas partners - can apply for funding and assistance from ZSL, by submitting a proposal to protect a local EDGE species. We support eight to ten new projects every year, and in total, we have been involved with 49 projects in 29 different countries since the EDGE programme began.

"Nor does it end there! We're still in touch with the first Fellows that we helped when the scheme began in 2007. Many of them are still working with their chosen EDGE species. We see our roles as training future conservation leaders and together, we're making a big difference." ✣

➤A sad end. These two Chinese giant salamanders were photographed on-sale to diners in a restaurant in Zhejiang, China, priced at $280 US dollars (£185) per kilo (2.2lb). Stemming the food trade in this species is crucial to its survival.
Photo courtesy Micromesistius.

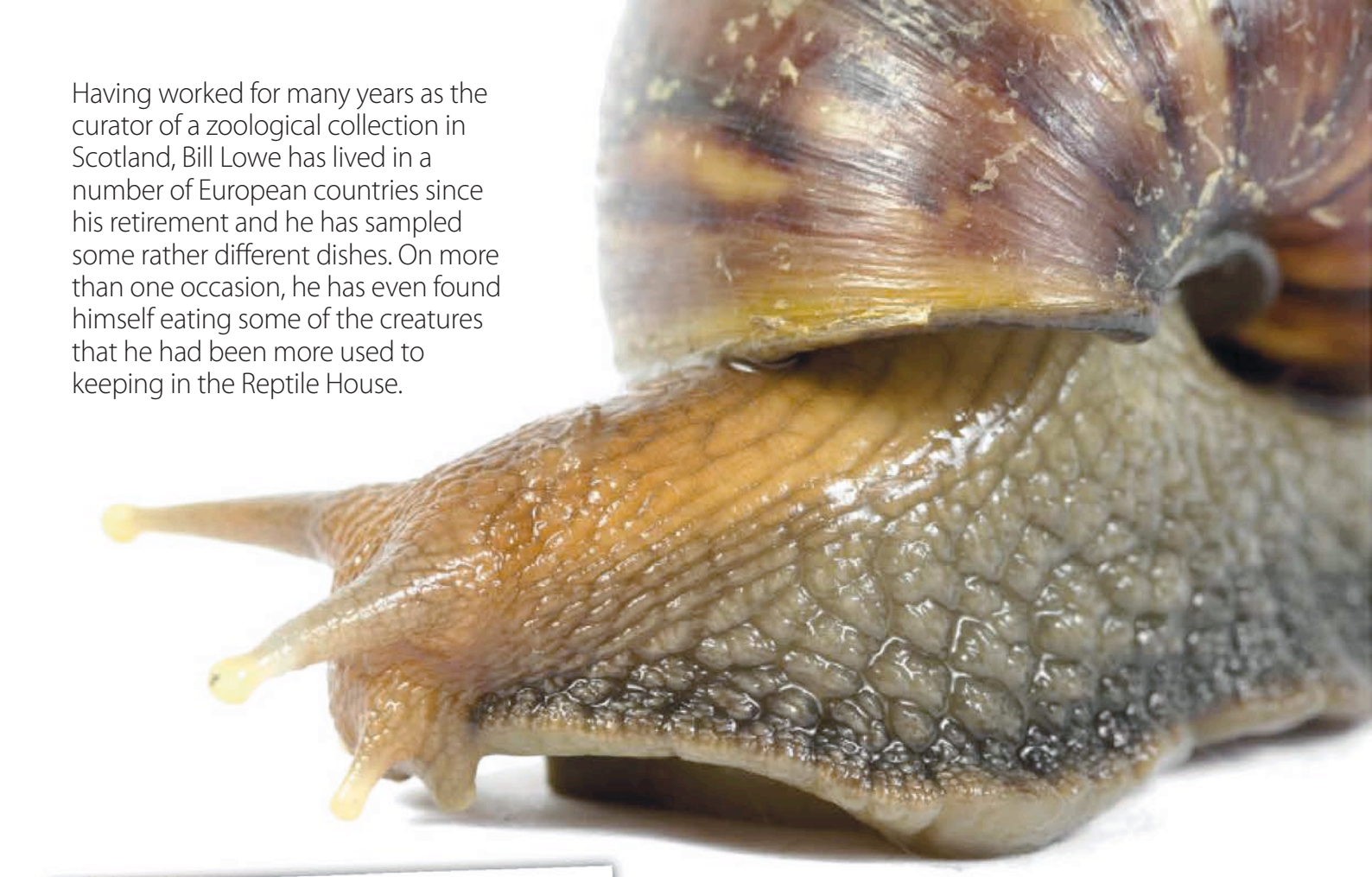
Did you know?

There is a very similar but slightly smaller species, known as the Japanese giant salamander (*Andrias japonicus*) found in Japan, growing to almost 1.5m (5ft), making it the second largest salamander in the world, after its Chinese relative.

See the Chinese giant salamander

Regent's Park, London, NW1 4RY. Tel 0344 225 1826. Buy tickets online: www.zsl.org and find the zoo's opening times here too.

Having worked for many years as the curator of a zoological collection in Scotland, Bill Lowe has lived in a number of European countries since his retirement and he has sampled some rather different dishes. On more than one occasion, he has even found himself eating some of the creatures that he had been more used to keeping in the Reptile House.



TALES FROM THE REPTILE HOUSE

France's first snail sanctuary?

I confess that I was not looking forward to eating them and no amount of garlic butter was going to make me change my mind! In the past I have sat down to what I believed to be chicken - only to subsequently discover that what I was eating was actually a plate of python when visiting the Iban tribe in a remote part of Borneo. I have also "enjoyed" frogs' legs in France - on one occasion even accompanied by pig's trotters - a weird combination if ever there was one!

A tough challenge!

Now I was facing my greatest culinary challenge. Yes, you've guessed it - my French neighbours had invited me to a snail festival! I did not wish to appear ungrateful when I received the invitation from Jean-Pierre, but I seriously contemplated developing a sudden "illness" which would leave me indisposed on the night in question. However, when it Rome… eat pasta and when in France, remember that gastropods are considered to be a gastronomic delight!

Sitting down for a meal that I knew would last well into the night, I reluctantly received my serving of snails. Chewy and gristly, despite being marinaded in garlic butter for the previous 24 hours, I struggled both with my conscience and my ability to swallow the poor things, especially due to the fact that I had been to the dentist that afternoon and was therefore only capable of eating with one side of my mouth.

Each snail seemed to take an interminable amount time to chew, as I sat at the dinner table wondering if anyone would notice if I slipped the odd half a dozen or so into my sporran, so that I would have the opportunity of giving them a decent burial in the garden the next morning!

Indeed, some of them had come from my garden in the first place, as Jean Pierre had spent the past week scouring all the neighbouring gardens in search of his quarry. Going round with his brightly coloured orange bucket, blue duffel coat and yellow Wellington boots, he reminded me of Paddington Bear.

I suppose that it was the memory of

➤ The idea of eating snails really did not appeal to Bill.


These snails are big!

this unfortunate experience that persuaded me many years later to set up a French snail sanctuary! Wanting to do something different, I decided that I had to keep a type of snail the size of which would be the envy of any Frenchman who enjoyed eating these gristly gastropods.

Giant pets

Now snails may not be the first animals that spring to mind, when most people consider the type of creatures that they would like to keep, but the giant African land snail is certainly a worthy contender for anyone seeking a decidedly unusual and usually trouble-free pet.

Giant African land snails (commonly abbreviated to GALS) are perfect for young children to keep as a first pet. In schools, they are often maintained by groups of youngsters under the supervision of their teacher.

I recall my grand-daughter, Victoria, proudly calling me on the telephone to tell me that she had been given the honour of being allowed to take the school's snail collection home with her to look after over the summer holidays.

At her school, the children were able to study the snails without the need for frequent handling, offering many of Victoria's classmates an ideal first introduction into the fascinating world of wildlife.

Different species

GALS can make good pets, as they are relatively low maintenance and fascinating to watch. Although they are apparently slow, they are capable of moving quite quickly, if they choose to do so. A number of different species of "giant" snails hail from Africa, but the two most commonly kept as pets here in the UK are *Achatina achatina* and *Achatina fulica*.

The former species is also known at the giant Ghana snail, or giant tiger land snail. These creatures are native to Ghana, Nigeria, Sierre Leone and other countries along the west coast of Africa. Individual examples of *Achatina achatina* can sport a shell measuring up to 25-28cm (10-11in) in length, and in a snail of this size, the body stretched out would measure approximately 36-38cm (14-15in).

Achatina fulica is a slightly smaller species. Adults attain a shell height of 5-8cm (2-3in) and up to 20cm (8in) in overall length. The shell is of a conical shape, being almost twice as high as it is broad. Both clockwise (dextral) and anti-clockwise (sinistral) swirls can be observed in the coiling of the shell, although the right-handed (dextral) version is more commonly encountered.

The colouration of the shell can be highly variable and, to some extent, is dependent on diet. The predominant colour is brown and the shell is usually banded. It is particularly tough and is said to have the highest metallic content of any species of snail.

This species is a native of East Africa, originating from Kenya and Tanzania and other neighbouring arid areas. These creatures are capable of aestivating for up to three years in times of extreme drought, sealing themselves into their shell. They do this by secreting a calcareous compound that dries on contact with the air - in much the same way as the European garden snail (*Cornu* (formerly *Helix*) *aspersum*) hibernates in winter.

Extremely adaptable

Both species of giant snail have the potential to be highly invasive, and colonies can be formed as the result of the introduction of a single gravid individual. Furthermore, both have been introduced accidentally to many different parts of the world as the result of demand for food in places where animal protein is in short supply.

The species was even discovered in China as long ago as 1931, as well as in parts of Taiwan, throughout India, the islands of both the Indian and Pacific oceans, and in the Caribbean. In the USA, GALS are well established in Hawaii and also in Florida, where a programme of eradication is currently underway. More recently, GALS have been observed in Bhutan, where they are considered to be an invasive species, attacking both domestic gardens and agricultural fields.

Outside of their native range, GALS will thrive in a wide variety of different habitats - especially in those where the climate remains mild throughout the year. In the wild, these giant snails can now be found occupying coastland regions, natural and planted forests, plantations and wetlands, as well as in scrub and shrubland and in urban areas.


▼ Some of these snails have very attractively marked shells.

Colour variants are now being bred by enthusiasts.

Did you know?

Both *Achatina achatina* and *Achatina fulica* are designated as "land snails" in order to differentiate between land snails and aquatic snails and other similar gastropods. As is suggested by the name, giant African land snails are much larger than our native species in the UK. Indeed, it is not unusual for the shells of certain individuals to resemble the size of a small clenched fist.

Dietary matters

GALS are voracious feeders and may serve as vectors for plant pathogens, often causing severe damage to agricultural crops and native plant species. They are listed as one of the top 100 invasive species in the wild.

Giant African land snails are herbivores, naturally consuming a wide variety of plant material, fruit and vegetables. In order to maintain sufficient levels of calcium to promote healthy shell growth, individuals have been known to ingest sand particles, minute stones and grit, tiny pieces of bone rasped from the skeletons of dead animals and birds and even concrete as sources of this vital mineral. In rare instances, they will even resort to consuming each other.

Despite their occasionally cannibalistic tendencies, Giant African land snails are popular pets here in the UK, with examples sporting attractive markings and patterns on their shells being particularly prized. They are easy to cater for. A constant supply of fresh fruit and salad vegetables should always be available to them. Those that I first kept in the Reptile House proved to be especially fond of cucumber.

Items such as lettuce and cucumber and other leafy greens, such as spinach, will form their basic diet. Remember that dark, leafy types of lettuce, such as romaine are more nutritious than head lettuce, such as iceberg.

GALS will also enjoy small pieces of fruit, such as apple, banana, grapes and nectarines. Melon, papaya, peach and plums may also be sampled, but do not offer acidic varieties of fruit (notably oranges, grapefruit, lemons and the like).

Vegetables may include items such as green beans, kale and corn-on-the-cob. Cabbage can be provided, as well as many other types of green vegetables. Tomato may also be taken.

All vegetables should be thoroughly washed in cold water to remove any traces of chemicals. Some snails may also be persuaded to eat brown bread and moistened dog biscuits. Any food remaining uneaten after a couple of days should be removed from the tank.

Furthermore, in order to remain in good health, GALS require a high content of calcium in their diet for their shell to remain strong and healthy. Providing cuttlefish bone is ideal for this purpose.

Wander along any beach and you are likely to come across pieces of cuttlefish deposited by the tide. Make sure that they are thoroughly cleaned before offering them to your pets. You can also buy this in pet stores, and sprinkle a powdered reptile supplement over their food once or twice a week.

▲ Giant land snails can climb well, stretching their bodies across gaps, to move off the ground or browse on plant matter.

▼ These snails are very adaptable in their feeding habits.

Housing

A simple aquarium made of either glass or plastic will provide your snails with a perfect home. It should be well ventilated. If you are short of the necessary cash to go out and buy a new tank, try searching on-line or looking in your local newspaper, or in the window of your neighbourhood newsagent.

Very often it is possible to pick up a second-hand fish tank - you may even be lucky enough to acquire one with a cracked base, or with one cracked panel of glass for little or no money at all, as it will be unsuitable for keeping fish. However, it is essential to add a well-fitting, secure lid, so as to prevent your snails from escaping.

The size of the tank will depend on the number of snails that you intend to keep. Each snail will require an area of at least 40 sq cm (16 sq in). Remember that your snails will grow quite large - and certainly a great deal bigger than any you are likely to find in your garden!

A perfect substrate for your tank would be peat-free compost, with the addition of a few bark chips and larger pieces of bark, under which your snails can hide, should they choose to do so. Add an earthenware flowerpot or two to provide a more interesting landscape and these will also

➤ Humid surroundings are vital for these snails.

serve to provide hiding spots.

You should line the floor of the tank with a thick layer of the chosen substrate, into which your snails will happily bury themselves. Use plain topsoil from a garden centre, rather than compost that may contain added fertilisers and which may be harmful to snails, or better still, see if you can find a suitable substrate in your local reptile store.

Avoid the use of any materials that may promote the growth of mould. Never use any top soil you have gathered yourself from the garden, as this may be contaminated with pesticides and/or fertilisers, as well as containing a range of different bacteria and pathogens that could be harmful to your snails.

The importance of humidity

The substrate should be kept damp, but it must not be allowed to become too soggy. Apply a light misting with warm water from time to time. Try to maintain the humidity level at around 60-70%, checking this with a hygrometer.

As an alternative to spraying, you can simply trickle a small amount of water into the soil. Placing small quantities of leaf moss on top of the soil will help to maintain the humidity. Remember that snails do best in damp, slightly humid conditions. You should clean the tank of snail trails and change the substrate once a week. Use only warm water when wiping the glass or washing the tank, as the use of detergents may prove harmful.

You will also need to provide a very shallow bowl of water for drinking purposes. It should be no more than a few millimetres in depth, because otherwise, your pets may easily drown. One designed for reptiles with the edges stepped is ideal, as it will help to prevent the snails from slipping into the bowl.

Providing a bowl of water for drinking purposes is not strictly speaking necessary, as long as the tank is misted regularly, bearing in mind that your snails will derive plenty of moisture from their food. You should include a heat lamp to maintain a temperature of between 20-25°C (68-77°F), under thermostatic control. Better still, use thermostatically controlled heat pads available for reptile habitats. They should be placed at the back of the tank, rather than underneath it, acting rather like a radiator.

Although they hail from tropical climates, GALS seem to adapt well to slightly lower temperatures, and depending as to where they are being kept, heating may be unnecessary. Bear in mind a heater will dry out their environment much faster, and you will need to ensure that a good level of humidity is maintained.

If the way in which your pets are being kept is too hot, too cold or too dry, they are likely to hide away, becoming inactive and a membrane may be seen to form over the shell aperture.

➤ Keeping two of these snails together is likely to result in fertile eggs.

Breeding concerns

Snails tend to be prolific breeders. GALS are simultaneous hermaphrodites - meaning that each individual possesses both male and female sexual organs, which are capable of producing both sperm and ova - so any two snails kept together are likely to reproduce!

Instances of self-fertilisation are rare, but not unheard of and are most frequent in small populations. Although each member of the mating pair can simultaneously transfer gametes to each other (bilateral mating), this is largely dependent upon the size of the two snails. Only those of a similar size will reproduce in this way. Two individuals of differing sizes will mate unilaterally, with the larger one acting as the female.

GALS have an intriguing mating behaviour. Their courtship can last for up to half an hour and the actual mating process can continue for a couple of hours at a time. Sperm can be stored in the body for up to two years and will remain viable.

The number of eggs laid will average around 200 per clutch. It is normal for five or six clutches to be produced each year - with the hatching rate frequently being as high as 90 per cent.

If you are keeping these creatures as pets, careful consideration should be given to their prolific breeding habits, because otherwise, you may well end up with many more than you can possibly accommodate. The best thing to do is to remove and destroy their eggs by ➤

Cuttlefish bone is important, alongside food, to ensure the snails have healthy shells.

immersing them in boiling water as they are laid. Never be tempted simply to deposit eggs or snails of any age in your garden, as this is strictly illegal.

Adult size is reached at around six months old, at which point the growth rate of these snails starts to slow up, but it may continue at a low level throughout their entire lives. This can typically be 5-6 years for a giant African land snail in the wild, but they have been known to live for up to 10 years. When it comes to their lifestyle, they will be at their most active at night, spending much of the day concealed, and often buried underground.

Buying and handling

Giant African land snails may be purchased from pet stores that specialise in more exotic creatures or, nowadays, it may be possible to buy them online. Otherwise, you may well find a fellow enthusiast who will be all too willing to part with some to provide the nucleus of your new collection.

Snails should be picked up gently by their shells. It is advisable to pick them up off the floor, rather than trying to remove them when they are adhered tightly to the glass in their tank. They do not object to being handled, but you must be gentle with them and avoid damaging the shell. Moistening your hands before holding them is to be recommended.

▲ Giant land snails lay clutch of around 200 eggs several times a year.

▲ The Florida rosy wolf snail is itself a snail-killer. Source PD.

The shell is at its most fragile at the base, where it is next to the body, so try to avoid picking them up by this part of the shell and be careful to provide sufficient support to the body and shell when doing so.

Always make sure that your hands and clean. Human sweat is easily absorbed by snails and can prove harmful, because of its salt content.

It is also important to remember to wash your hands thoroughly after handling your snails, or any equipment associated with them, as there is a slight possibility (in common with other pets) that these snails might potentially carry *Salmonella* bacteria. Always be sure to keep their feeding bowls and any other equipment completely separate from any reptiles, amphibians and the like which you may also keep.

In the wild, GALS often support a parasitic nematode called *Angiostrongylus cantonensis* that, in humans, can cause a very serious form of meningitis. Cases usually result from a person having eaten a raw, or undercooked snail, but even handling can result in infection. However,

▼ Always remember the need to handle these snails with great care.

A biological catastrophe

In some countries, efforts have been made to promote the use of the GALS as a food resource – with the added bonus of helping to reduce populations. However, this active promotion of non-native species has been criticised for encouraging the further deliberate introduction of the species.

One well-meaning, but subsequently catastrophic attempt to biologically control this species occurred on an island in the South Pacific, where colonies of *Achatina fulica* were deliberately introduced as a food reserve for the American military forces during the Second World War.

Some of these snails escaped and this then necessitated the further introduction of a carnivorous species, called the Florida rosy wolf snail (*Euglandina rosea*) in an attempt to control them. The introduced Florida rosy wolf snails were more inclined to prey on native snails however, causing the extinction of all but a few of the native *Partula* species within no more than a decade.

The snails were assured of a safe future!

this is not likely to be an issue in the case of those bred here in collections.

Your snails themselves should suffer from very few health problems, provided that they are maintained in the right conditions. A healthy snail should have a clean, unbroken shell, and there should be no lumps or discoloured patches on its body.

Religious significance

In Brazil, *Achatina fulica* snails are used by some practitioners of Candomblé. This is an African-Brazilian religion that has about two million followers. It is a syncretic religion, which means that it is a combination of various beliefs.

It can be traced back to the days of the slave trade, when enslaved Africans brought their beliefs with them when they were transported to South America. Music and dance are important parts of Candomblé ceremonies and they include ritualistic offerings of giant African land snails to the deity Oxalá.

A strange turn of events

When I sat down to my first and (hopefully) last plate of snails, I almost felt that I needed to be praying to the gods myself - praying that I wouldn't have to actually eat them!

Little did I imagine as I set about chewing my way through what I was assured was a gastronomic delight, dribbling garlic butter down my chin in the process, that one day I would have the opportunity to make amends.

I was visiting the house of lady who owns a chamber d'hôte in a small village in the Charente region of south-west France. Here I was introduced to some of her French neighbours over dinner.

I learnt that one of my fellow dinner guests was breeding GALS with such a degree of success that he was overrun with them. Learning that I had once been in charge of a public reptile collection and that I had an abiding interest in all creatures great and small, he offered to provide me with the nucleus of my own colony.

I hardly thought I could refuse his offer and, lo and behold, a few days later the lady owner of the chamber d'hôte arrived on my doorstep holding a small brown cardboard box containing a dozen giant African land snails.

Here finally was my opportunity to atone for my reluctant consumption of their fellow molluscs at that previous dinner party. Without further ado, I accepted them graciously, deciding there and then that, when in France… set up a snail sanctuary! ✣

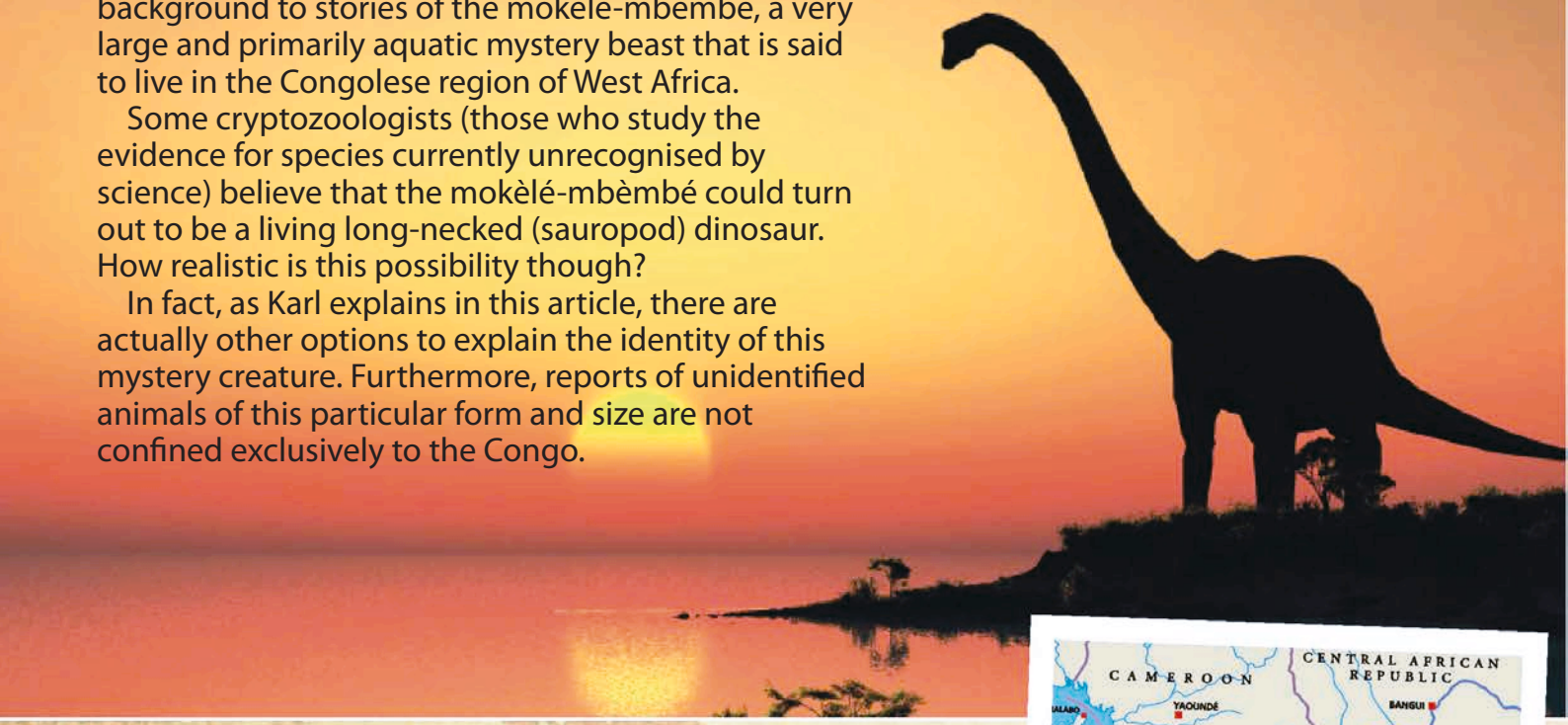
LIVING DINOSAURS IN AFRICA?

Seeking the true identity of mokèlé-mbèmbé

In last month's issue, Dr Karl Shuker described the background to stories of the mokèlé-mbèmbé, a very large and primarily aquatic mystery beast that is said to live in the Congolese region of West Africa.

Some cryptozoologists (those who study the evidence for species currently unrecognised by science) believe that the mokèlé-mbèmbé could turn out to be a living long-necked (sauropod) dinosaur. How realistic is this possibility though?

In fact, as Karl explains in this article, there are actually other options to explain the identity of this mystery creature. Furthermore, reports of unidentified animals of this particular form and size are not confined exclusively to the Congo.



▲ The location of the Republic of the Congo, and the location of Lake Télé, an area where the mokèlé-mbèmbé is said to be present (arrow).

When it comes to trying to establish a possible identity for the mokèlé-mbèmbé, always assuming that it is real and not just a fictitious monster of traditional native folklore, what might it be? The most conservative explanation is that it is merely a misidentified known species, but none of the major candidates – elephant, hippopotamus, manatee, crocodile or python – offer even the most superficial degree of resemblance to descriptions of the mokèlé-mbèmbé.

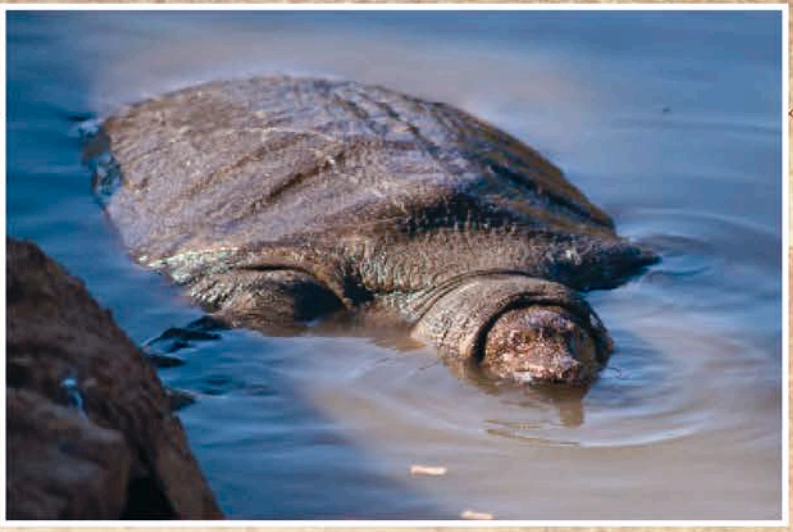
▼ A distinguishing feature of the mokèlé-mbèmbé is its three-toed appearance, whereas crocodiles for example have five toes, which is a very obvious point of difference.

Moreover, the local people who know the mokèlé-mbèmbé are very adept at accurately identifying these other animals, which are all very familiar to them. It is therefore really not feasible that they could somehow invent a totally new creature through repeated misidentification of any of these animals? For the same reason, the notion that they would not realise that the mokèlé-mbèmbé is nothing more than a submerged elephant with only its trunk protruding through the water surface, (as proposed by one Western scientist), does not seem credible either.

A plausible reptilian identity?

Rather more likely, perhaps, is that at least some sightings may have been of extra-large specimens of the Likouala's long-necked, soft-shelled freshwater turtle (*Trionyx triunguis*). If seen with only the upper surface of its shell and its vertical neck above the water surface of a lake, this species may well look like reported eyewitness descriptions of the mokèlé-mbèmbé. However, it rarely exceeds 1m (3ft) long, and even allowing for Congolese claims that *Trionyx* specimens twice that size have been reported, this is still much smaller than the sizes that have been claimed for the mokèlé-mbèmbé.

Another identity that has been suggested for the mokèlé-mbèmbé is that this neodinosaur (meaning 'new dinosaur', reflecting its continued survival) may actually be a specialised



Could giant soft-shelled turtles have given rise to belief in the mokèlé-mbèmbé?

giant monitor lizard with an extraordinarily long neck. However, no such species is known either from modern times or from the fossil record, and monitors have feet with five toes. Consequently, they would not create the famous three-toed prints attributed to the mokèlé-mbèmbé and which also, interestingly, characterised the sauropod dinosaurs as a group.

Also, virtually all monitors are carnivorous, whereas the mokèlé-mbèmbé is reportedly exclusively herbivorous. Moreover, monitors are common in the Congo and therefore very familiar creatures to the people in that region. It therefore seems strange that if the mokèlé-mbèmbé was simply an extra-large version – something on the lines of the Komodo dragon (*Varanus komodoensis*) – why have the Congolese natives never described it as such?

The dinosaur option

Consequently, dramatic though it may seem, a living sauropod dinosaur remains the best morphological match for the Congo's elusive water dragon – and perhaps for good reason. One of the major riddles concerning the great dinosaur extinction at the end of the Cretaceous Period some 64 million years ago is what could have caused the death of every single species of dinosaur alive at that time?

There was a tremendous diversity of ecological, physiological, and morphological types, bearing in mind that the group represented the dominant vertebrate life form on the planet at that stage. Equally puzzling is the fact that this mass extinction spared several other reptilian groups that were certainly no more varied than (if, indeed, they were even as diverse as) the dinosaurs.

The largest known species of monitor is the Komodo dragon, found on the Indonesian island of this name, and yet again, like others of its kind, it has five, not three toes.

A legacy from that era

Their modern representatives are familiar to us today, such as crocodilians, snakes, lizards, tortoises and turtles, and even a single lineage of sphenodontids, as represented by New Zealand's modern-day tuatara (*Sphenodon punctatus*). What possible agent of destruction could have been so specific and ➤

Did you know?

While it may seem unlikely that a dinosaur could have survived undetected for over 64 million years, it is worth considering the case of the coelacanth. Known only from the fossil record, this ancient fish was believed to have gone extinct in the late Cretaceous Period too, just like the dinosaurs.

In 1938, however, a living population of coelacanths was found off the coast of east Africa, close to the Comoros Islands near Madagascar. A second, separate Indonesian species of coelacanth has since been discovered as well, being described in 1999.

A coelacanth. These are large fish, and can weigh 60kg (132lb) or more. Photo courtesy Citron / CC-BY-SA-3.0

Monitor lizards often venture into water, but no species is known to have a neck as long as that described for the mokèlé-mbèmbé.

exclusive as to annihilate the dinosaurs entirely, while permitting these other reptilian groups, including the dinosaurs' close relatives, in the guise of the crocodilians, and also (as many scientists believe) their direct descendants – birds – not only to persist, but also to have diversified since then?

It is this anomaly that has persuaded some cryptozoologists to consider the possibility that a few dinosaur lineages did manage to survive after all, staying relatively unchanged in form through the following 64 million years and lingering in untroubled seclusion within certain remote, inaccessible regions of the globe where they have faced little competition from any ecologically-equivalent mammals of large size.

Happily, with recent advances in DNA analysis, any physical remains obtained from a mokèlé-mbèmbé should swiftly assist in determining its true zoological identity. Obtaining those all-important remains, however, is another matter entirely!

Nothing of the mokèlé-mbèmbé killed in 1959 by pygmy tribesmen at Lake Télé in the Republic of the Congo still exists. Its body was discarded after people died, having eaten its flesh. There could, however, possibly be unrecognised skeletal remains being kept in a village in the area where it reputedly occurs.

Ranging further afield

Reports of mokèlé-mbèmbé-like beasts are not wholly confined to the Congo, Cameroon, and Gabon by any means. Similar creatures have also been reported from a number of other tropical African countries, and, highly significantly, their morphological descriptions remain remarkably consistent throughout.

Two notable localities are Zambia, in particular in the area of Lake Bangweulu, where the creature is dubbed the *mbilintu*, as well as the area formerly called Barotseland (now a northwestern district of Zambia) where it is termed the *isiququmadevu*. Further north, in the immense swamplands of the Democratic Congo (formerly Zaire and, before that, the Belgian Congo), local people refer to this creature as the *irizima*. Reports have also been filed from the Central African Republic, and it is known variously there as the *badigui*, *diba*, *guaneru*, *ngakula-ngu*, and *songo*.

▲ The tuatara is a survivor from before the age of the dinosaurs. This family of reptiles used to have a much wider distribution.

▼ Reports of similar creatures extend down to Zambia.

▲ Lake Bangweulu, shown here in red, is connected into the Congo River system, so it is perhaps not surprising that similar reports of mokèlé-mbèmbé-type creatures have originated from here.
Map courtesy Kwamikagami.

Historical evidence

There are even some old but remarkably sauropod-reminiscent gold weights in existence, produced by Ashanti gold dealers in Ghana. Nor should we forget the series of ancient bushman paintings discovered in Zimbabwe's Goromonzi

Hills.

These artworks include a depiction of a mysterious beast astonishingly similar in form to a sauropod with its long neck emerging from a swamp. This is surrounded by other depictions that are readily recognisable as well-known creatures, such as hippos, elephants, giraffes and the like.

Their close proximity to the mystery beast and accurate portrayal in the paintings indicate that the sauropod-lookalike was just as real to the bushmen as the other, familiar animals, and presumably just as accurately drawn by them as well.

A Biblical reference?

Perhaps the most unexpected location for a possible mokèlé-mbèmbé, however, is within the *Holy Bible* – yet such a prospect cannot be wholly discounted. A biblical monster that has never been satisfactorily identified with any known animal alive today is the behemoth, which is described in the book of Job (40:15-24) as follows:

"Behold now Behemoth, which I made with thee; he eateth grass as an ox.

Lo, now, his strength is in his loins, and his force is in the navel of his belly.

He moveth his tail like a cedar: the sinews of his stones are wrapped together.

His bones are as strong pieces of brass; his bones are like bars of iron.

He is the chief of the ways of God; he that made him can make his sword to approach unto him.

Surely the mountains bring him forth food, where all the beasts of the field play.

He lieth under the shady trees, in the covert of the reed, and fens.

The shady trees cover him with their shadow; the willows of the brook compass him about.

Behold, he drinketh up a river, and hasteth not: he trusteth that he can draw up Jordan into his mouth.

He taketh it with his eyes: his nose pierceth through snares."

▲ A behemoth (top) with a leviathan (bottom), as portrayed by William Blake. Source PD.

Over the centuries, four main suggestions to explain the likely identity of this mysterious beast have been put forward by theological and zoological scholars. These are an ox, a Nile crocodile, an elephant or a hippopotamus. The least popular proposal is the ox, because apart from its herbivorous nature, it has no similarity to the behemoth.

Similarly, only the *New English Bible* supports the crocodile's candidature - certainly, the concept of a vegetarian crocodile is an implausible one, to say the least. The elephant's supporters are also few - only Prof. George Caspard Kirschmayer in *Un-Natural History of Myths of Ancient Science* (1691) and Dr Sylvia Sikes in *The Natural History of the African Elephant* (1953) have seriously attempted to link these two great beasts with one another.

A new identity proposed for the behemoth

The most popular and (until recently) most favourable pairing of the behemoth has been with the hippopotamus - whose cavernous mouth, prodigious drinking capacity, mighty build, sturdy skeleton, swamp-dwelling lifestyle, herbivorous diet, and status as the largest animal native to the Bible lands compare satisfactorily with the behemoth - but not conclusively.

How, for example, can the hippopotamus "moveth his tail like a cedar"? This description implies a very long, powerful tail - not the puny, relatively inconspicuous appendage sported by the hippo.

But then came a late entry in the behemoth identity stakes - a living sauropod. As veteran cryptozoologist Professor Roy P. Mackal, seeker of the mokèlé-mbèmbé during the 1980s, persuasively pointed out in his book ➤

▼ Nile crocodiles – like other crocodilians – are carnivores, eating no plant matter. They can leap from the water, as seen here, to catch water birds, extending their neck as they do so. But the mokèlé-mbèmbé is strictly herbivorous, based on native accounts.

▲ Could there be an unrecognised elephant killer in Africa's swamps?

entitled *A Living Dinosaur?* (1987), not only the description of the behemoth's tail but also all of the features hitherto likened to the hippopotamus are equally applicable to one of these giant vegetarian dinosaurs.

Moreover, the great size attributed to the behemoth, far exceeding that of the hippo, would be much more compatible to a sauropod of the mokèlé-mbèmbé's proportions. Compare the Bible's description of the behemoth (given above) with Mackal's argument to support his sauropod identity for it (given below), and judge for yourself:

"The behemoth's tail is compared to a cedar, which suggests a sauropod. This identification is reinforced by other factors. Not only the behemoth's physical nature, but also its habits and food preferences are compatible with the sauropod's. Both live in swampy areas with trees, reeds and fens (a jungle swamp). Indeed, the identification of the biblical behemoth as a sauropod dinosaur provides excellent correspondence between the descriptive features in the biblical text and the characteristics of these dinosaurs as inferred from the fossil record."

Support elsewhere?

So far in this article, our investigation of possible living dinosaurs inhabiting the vast, scarcely explored swamplands of the People's Republic of the Congo has concentrated upon the mokèlé-mbèmbé, plus its possible kin in neighbouring lands. However, some other, very different mystery beasts that compare surprisingly well with certain other iconic dinosaurs from prehistoric times have also been reported from this same region of Africa.

These reports include a terrifying creature dubbed by the native people there as the *emela-ntouka* or 'killer of elephants'. The possible presence of other, perhaps unrecognised survivors from the age of the dinosaurs in turn actually gives greater credence to the identity of the mokèlé-mbèmbé itself as a sauropod.

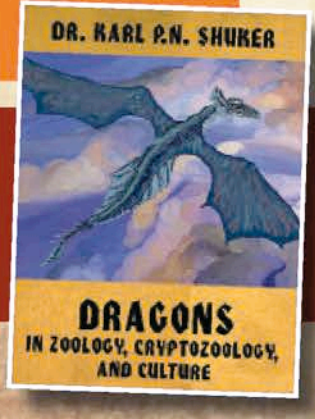
** Dr Karl Shuker BSc PhD FRES FZS is a zoologist, author and broadcaster who is pre-eminent in the field of cryptozoology – the study of animals whose existence is not proven.*

Next month

In the concluding part of this series, Karl delves further into the realm of dinosaur-like creatures that might survive in this largely uncharted and little studied area of Africa. Aside from the possible sauropod dinosaur in the guise of the mokèlé-mbèmbé, and the emela-ntouka as well, could there also be a living descendant of stegosaur lineage still flourishing in this region?

Discover more about such mysteries

Karl's recent book entitled *Dragons in Zoology, Cryptozoology, and Culture* (Coachwhip Publishing, 2012, ISBN 978-1616462154), which extends to 220 pages can be purchased from bookshops or online, and is priced at approximately £20.



VETERINARY CASEBOOK

When we think of species affected by metabolic bone disease (MBD), it is usually lizards or tortoises that spring to mind. Amphibians, on the other hand, are commonly overlooked in this regard, despite their similar biological requirements, and in fact, they can be badly afflicted too. Specialist veterinary surgeon Sarah Pellett and her colleague Craig Mackinlay describe a case of MBD that they encountered recently in a cane toad (*Rhinella marina*).

MBD in a cane toad

Metabolic bone disease (MBD) is a condition characterised by poor bone calcification, often as a result of low blood calcium. The most common causes are the absence of calcium supplementation in the diet and a lack of provision of an appropriate spectrum of ultraviolet light.

What can go wrong

The mechanism by which the body controls its calcium levels is quite complex. When blood calcium levels drop, parathyroid hormone (PTH) is released from the parathyroid gland in the neck. This acts on the kidneys to reduce calcium excretion, stimulates vitamin D to increase absorption of dietary calcium, and releases sources of stored calcium from the bones. A combination of these mechanisms will result in an increase in blood calcium levels.

Oreo undergoing his scan, which provided greater insight into his condition.

Clinical photos courtesy Sarah Pellett.

Once blood calcium has risen to a suitable level, then a separate hormone, called calcitonin, is released. This then acts on the kidneys to increase calcium excretion, reduces absorption of dietary calcium, and causes calcium to be laid down in bones. Collectively, the end result in this case is a decrease in blood calcium levels.

This process can go wrong, however, if the animal is anorexic or calcium is not provided in the diet as then there is nowhere for the body to get calcium, other than from its existing bone stores. This causes thinning and weakening of the bones until they either break or become so soft that they can no longer keep their normal shape and just bend. In more severe cases, the animal will become too weak to move as calcium is also required for muscular movement, and it will eventually suffer from muscle tremors and seizures.

An X-ray that confirmed Oreo was suffering from MBD. Note the poor visibility of the limb bones.

The case of Oreo

Oreo, a cane toad, was presented with a two and a half month history of anorexia and weight loss. On initial examination, he was found to have a soft jaw and an ulcerated tongue. He was holding his legs at odd angles and there was a swelling that could be felt in his body cavity. His soft jaw and limb deformities were very suggestive of a diagnosis of MBD, but the lump in his coelom also warranted investigation, in case he had swallowed something unusual.

X-rays were taken to assess the density of Oreo's bones and to allow an initial view of the internal lump. MBD was immediately apparent, with his bones appearing grey rather than white. The cortices (the hard bone surrounding the marrow) were narrow and an abnormal curvature of the long bones of the limbs was clearly visible.

The X-rays also confirmed the presence of a mass in the coelom but gave no real clues as to its cause. An ultrasound scan was performed therefore, to give a better understanding of this mass.

The scan confirmed the lump was formed of soft tissue, with no evidence of coelomitis (inflammation of the internal lining of the body cavity) being evident. This ruled out a foreign body in the intestinal tract so other possibilities had to be considered including an enlarged internal organ, a bacterial or fungal granuloma or a tumour.

Treatment starts

Ideally, Oreo needed a general anaesthetic to perform either an endoscopy (looking into his body with a small viewing tube) or exploratory surgery to investigate the mass further. However, in his current condition, the anaesthetic risk was far too high. It was therefore decided to send him home with a course of antibiotics and painkillers, along with a calcium/vitamin D3 supplement, and wait until he was strong enough to undergo further investigations.

Unfortunately, after an initial improvement in his condition, Oreo died at home two weeks after starting treatment. His case highlights a common problem seen in reptile and amphibian practice; that of multiple, concurrent conditions - either related or unrelated - that can interfere with the investigation of the other ailment.

MBD is one of the most common nutritional problems seen in amphibian veterinary practice. It can be avoided by feeding appropriate foodstuffs; all adult amphibians are insectivores, with some species like the cane toad adapted also to eating occasional vertebrate prey.

All invertebrate prey used as food for amphibians should therefore be adequately gut-loaded, using a calcium-based supplement, for at least 48 hours beforehand. Careful exposure to a full-spectrum UVB light may also be recommended for some species. ✣

* Both Sarah and Craig are based at Animates Veterinary Clinic Ltd, 2 The Green, Thurlby, Lincolnshire PE10 0EB. Tel 01778 42046.

Puzzle Corner

Find the solutions to these puzzles by following the clues, to discover which reptiles, amphibians or invertebrates are hidden within them.
The answers can be found on p66.

Snakes Alive

SOME SORT OF SNAKE HAS BEEN HIDDEN IN THE WORDS OF EACH SENTENCE BELOW. A RAT SNAKE APPEARS IN 'HE FELL OVER A TIN IN THE ROAD'. CAN YOU FIND THE OTHER FIVE?

HE FELL OVER A TIN IN THE ROAD.

JUMBO AND RAJA ARE ELEPHANTS.

AN ALLOY MAY INCLUDE ZINC OR NICKEL.

THEY SEEM HAPPY THO' NOT MERRY.

A WALK IN GOOD WEATHER IS FINE.

IS BORING ART ERASED FROM GALLERY?

Turtle Doku

L		D	S		
				L	
I		E			
	R				E
D			I		
		S			R

Complete the grid so that each row across, each column down and each smaller inner box contain all six letters in the word SLIDER

Midmost

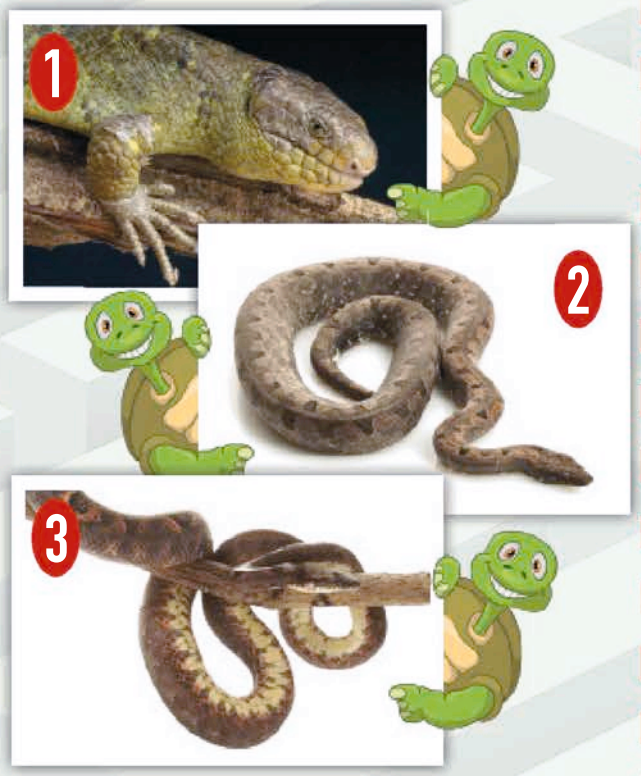
BAIL	BEAN	BOOM
FACE	FURY	GAZE
HATE	HERD	LOCH
MOON	POND	REAL
STIR	TIER	TOTS

Find five letters of the alphabet, each of which might be placed slap bang in the middle of three different words in the grid, left, to form three longer words. Then rearrange all five added letters to spell out a type of monitor lizard. The G forming BEGAN, REGAL and TIGER will give you a one of them.

_ _ _ _ _

Where in the World?

On which group of islands are these three species to be found, and what are they?



Linkage

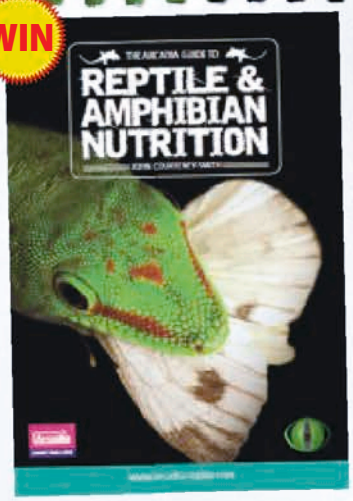
Can you recognise these reptiles and figure out what links them to a different type of animal?

YOU & YOUR Reptiles

WIN

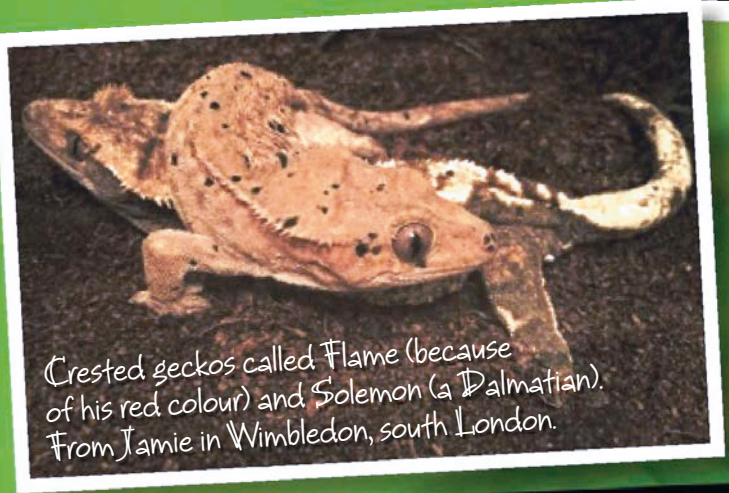
If you have a favourite photograph of one of your reptiles, amphibians or invertebrates which you'd like to see included in the magazine, then email us a **high resolution** digital image to **prk.ed@kelsey.co.uk.** Please include details about the subject, confirm anyone in the picture is happy for it to be published and that you took it.

Also, tell us where you live, because the best photograph, as judged by the *Practical Reptile Keeping* team, will win a prize. This month's winner will receive a personally signed copy of *The Arcadia Guide to Reptile and Amphibian Nutrition*, written by John Courteney-Smith. This ground-breaking 272 page colour book covers vitamin and mineral groups, uses and interactions; food categories; supplementation; gut flora and parasites; gut loading; livefood safety, nutrition and variety with 23 sources of livefood covered, plus much more!



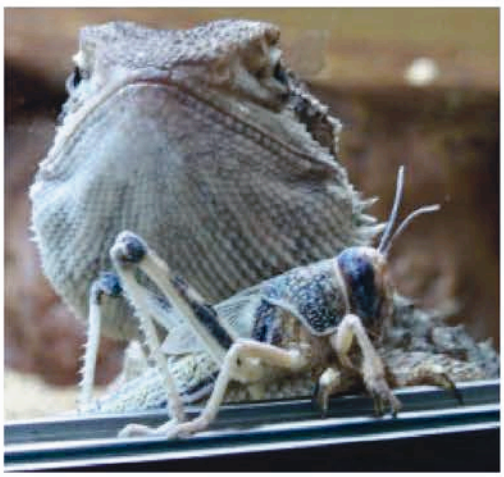
STAR PICTURE

Ares, who is a blue bar Ambilobe panther chameleon. Photographed by Benjamin from Cambridgeshire.



Crested geckos called Flame (because of his red colour) and Solemon (a Dalmatian). From Jamie in Wimbledon, south London.

➤ Vanessa's Rankin's dragon, eyeing up a meal. They live in Mildenhall, Suffolk.



A clutch of baby Hermann's tortoises, just a few days old. From Nic in Wigan, Lancashire.

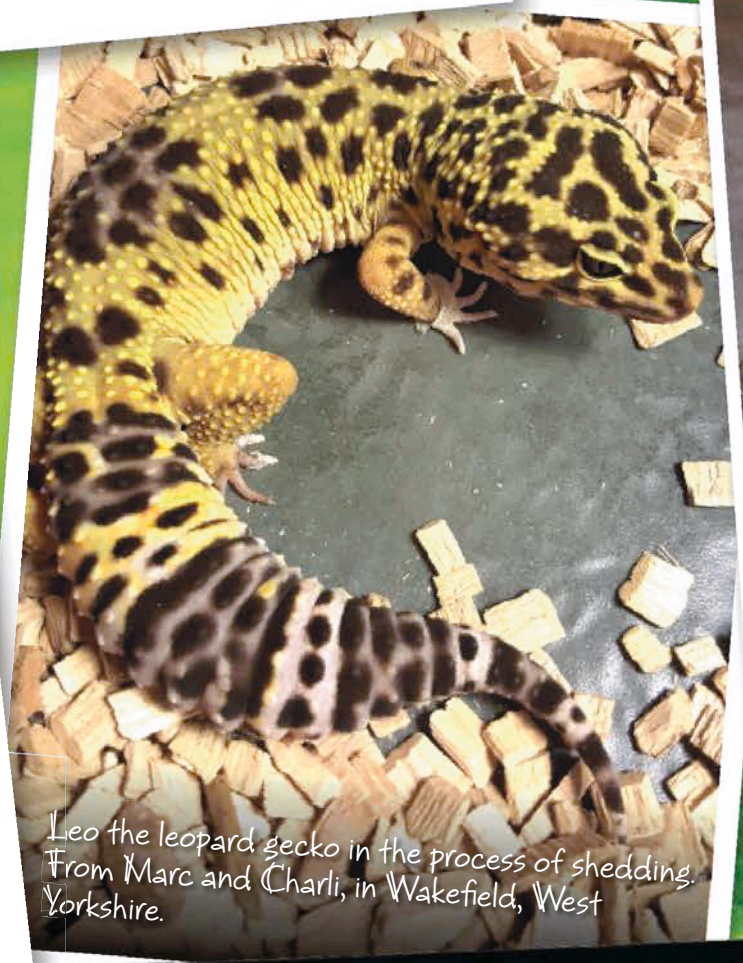
Two leopard tortoises called Eddie and Stobart, at a year old. From Catherine in Stockport, Cheshire.

Vader, a rescued leopard tortoise, who has now been nursed back to health by new owner Emma.

Emma's new baby Tokay gecko, called Hannibal (Lecter).

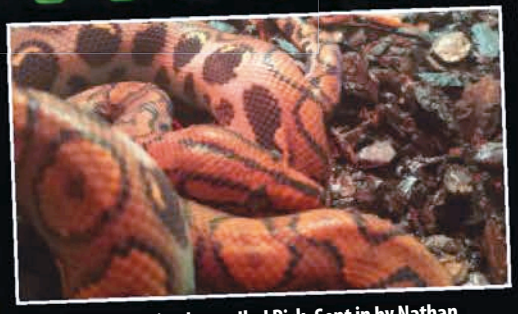
A Macleay's spectre stick insect, giving a ride to a young hatchling. Sent in by Marie.

Naz, a super Dalmatian crested gecko. From Neil in Monmouthshire.



Leo the leopard gecko in the process of shedding. From Marc and Charli, in Wakefield, West Yorkshire.

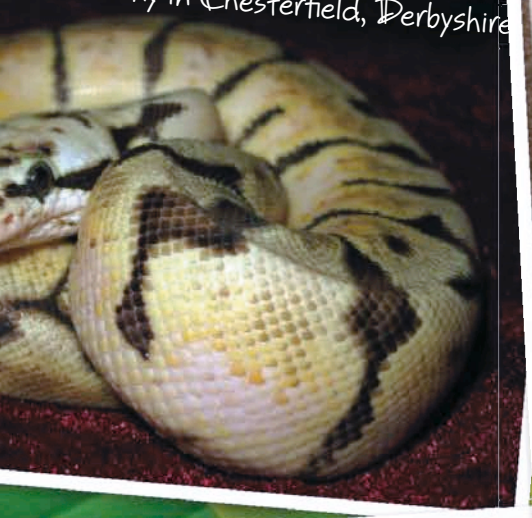
A grass snake, photographed by Marie in Oxfordshire.



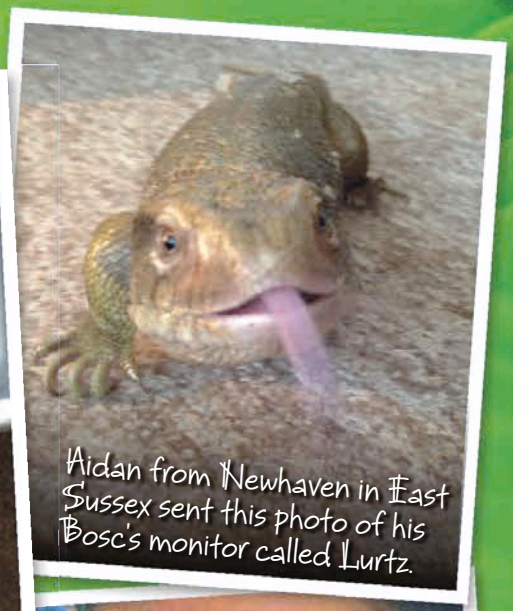
A beautiful Brazilian boa called Rick. Sent in by Nathan.

Fudge, a lemon blast ball (royal) python. From Nathan.

umblebee ball (royal) python called Tali
From Tony in Chesterfield, Derbyshire

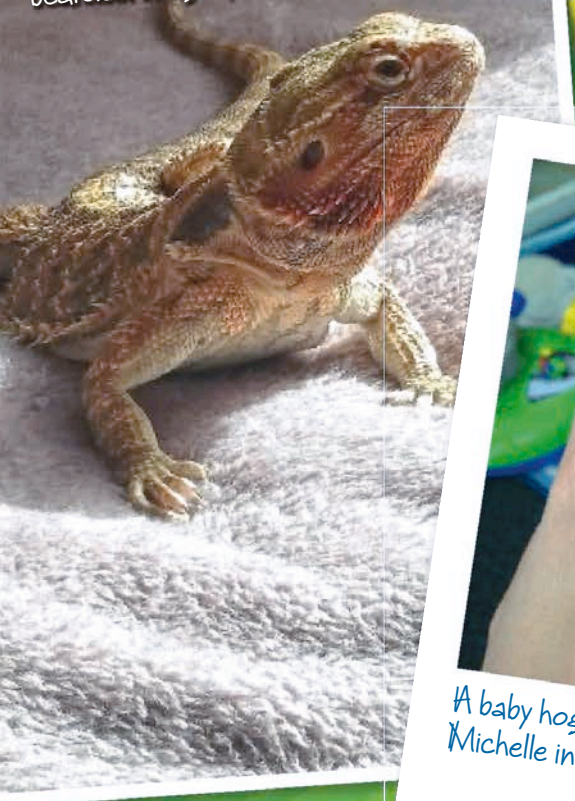


▲Tortoise bath time, with Ethel, Eric and Ernie! From Ben who live in Toft, near Cambridge.

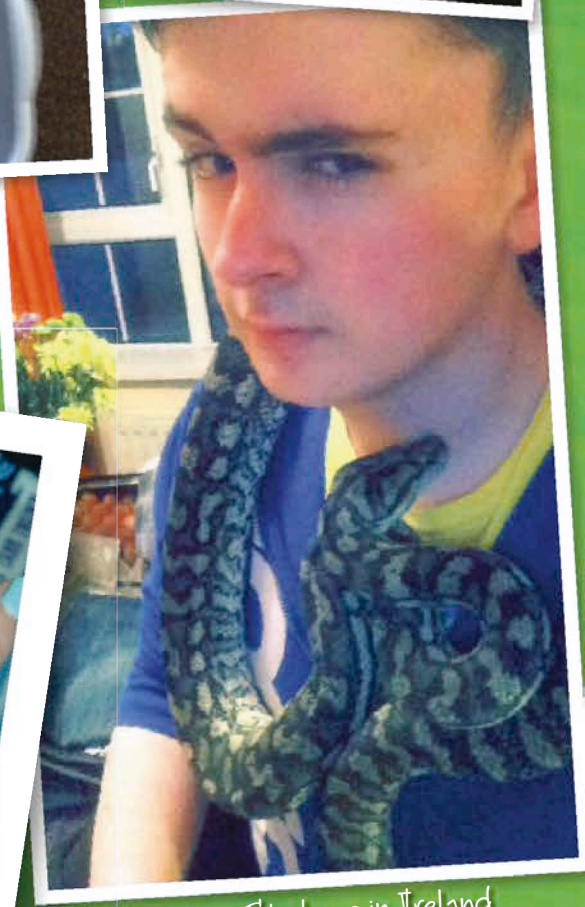


Aidan from Newhaven in East Sussex sent this photo of his Bosc's monitor called Lurtz.

Laurynas from Aberdeen in Scotland sent this photo of her nine month old bearded dragon, called Punisher.



A baby hognose snake called Harold. From Michelle in Glazebury, Cheshire.



▲Dean from Strabane in Ireland, with Lucifer, a rescue carpet python, now four years old and about 2.1m (7ft) long.

Red-eyed tree frog, from John in Horsham, West Sussex.

A white-lined or palm gecko, photographed stalking food. From Mark in Hullavington, Wiltshire.

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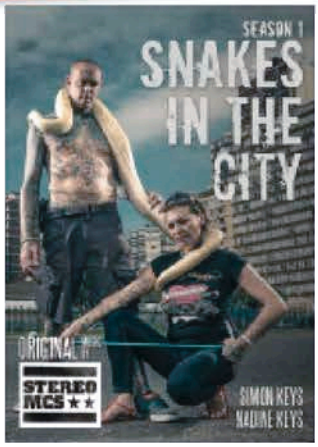
.Next month.

NEW TECHNIQUES FOR FROGS

A different approach to keeping the *Rhacophorus* or 'cave-dwelling' frogs is revealed by Mikhail Bagaturov in his article about breeding these amphibians successfully.

ON SALE ✦ ON SALE
Friday, July 24th
ON SALE ✦ ON SALE

In the Summer Practical Reptile Keeping issue



STAY SAFE!

Don't miss our exclusive interview with professional snake catcher Simon Keys, who with his wife Nadine stars in the National Geo television series, *Snakes in the City*. Together, they battle to keep Durban's homes free from deadly snakes, moving them to more suitable surroundings.

MANAGING NEW ARRIVALS

Acquiring an additional animal for your collection is exciting, but can you be sure that this will not introduce disease? Discover the guidelines here, for care and handling, to ensure that all your stock is as safe as possible.

Puzzle Corner

SNAKES ALIVE: RAT, BOA, CORN, PYTHON, KING AND GARTER.

TURTLE DOKU:

L	E	D	S	R	I
R	S	I	E	L	S
I	D	E	R	S	L
S	R	L	D	I	E
D	L	R	I	E	R
E	I	S	L	D	S

MIDMOST: ARGUS
A HEARD, LOACH, STAIR
R FARCE, FURRY, MORON
G BEGAN, REGAL, TIGER
U GAUZE, POUND, TOUTS
S BASIL, BOSOM, HASTE

WHERE IN THE WORLD? All three species occur on the Solomon Islands, which lie to the east of Papua New Guinea and to the north-east of Australia, within the area of the Pacific Ocean known as Polynesia. They are as follows:
1. The Solomon Islands or monkey-tailed skink *(Corucia zebrata)*.
2. The Solomon Islands ground boa *(Candoia carinata paulsoni)*.
3. The Solomon Islands tree boa *(Candoia bibroni australis)*.

LINKAGE: The common name of all three species includes a reference to wild cats. They are as follows:
1. Leopard gecko *(Eublepharis macularius)*.
2. Panther chameleon *(Furcifer pardalis)*.
3. African tiger snake *(Telescopus semiannulatus)*.

PLUS ALL OF OUR REGULAR FEATURES

including veterinary care with Veterinary Casebook, Out of Africa, Herpetological Mysteries, You & Your Reptiles, plus Tales from the Reptile House.

**These are just some of the features planned for the next issue but circumstances outside our control may force last-minute changes. If this happens, we will substitute items of equal or greater interest.*

***Practical Reptile Keeping* and the Pet Advertising Advisory Group recommend that if you decide to buy a reptile or amphibian, you should:-**

- **RESEARCH BEFORE YOU BUY.** Be sure you fully understand and appreciate the needs of the reptile or amphibian you are interested in, and that you can provide a suitable environment.
- **SEEK ADVICE FROM BOOKS,** the internet and your local veterinary practice who may also be able to recommend a suitable expert for additional advice.
- **ENSURE YOU KNOW** what facilities are necessary to provide a suitable environment for the animal – e.g., vivarium, temperature, humidity, light quality etc..
- **ENSURE YOU BUY** from someone who specialises in the animal you are interested in.
- **VISIT THE ANIMAL** you are intending to buy.
- **CHECK THAT THE ANIMAL'S** accommodation is clean, it is supplied with the appropriate food and water, and that special equipment for maintaining the animal's environment (e.g., heat lamps or UV lights, etc) is working properly.
- **ENSURE THAT ALL RELEVANT PAPERWORK IS AVAILABLE FOR INSPECTION WHEN YOU VISIT.** This could include any necessary permits such as CITES registration documents, Dangerous Wild Animals Licence or other documentation.
- **IF ANY PAPERWORK IS UNAVAILABLE** and has to be sent on, obtain a written commitment as to when it will be delivered.
- **ENSURE THAT THE ANIMAL YOU ARE BUYING** is healthy and free from signs of injury or disease.
- **REMEMBER THAT SOME REPTILES CAN GROW VERY LARGE** and some species can live for 50 years or more. Veterinary care can be very expensive.

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